THE ENGINEER

A Seven-Day Journal

A Colonial Agricultural Machinery Advisory Committee

THE Secretary of State for the Colonies, Mr. Oliver Lyttelton, has announced the appointment of a committee, entitled the Colonial Agricultural Machinery Advisory Committee, to advise him on the problems of developing and expanding the use of agricultural machinery and implements in the Colonial territories. The first meeting of the committee was held in London on Wednesday of last week. Recommendations for the setting up of a committee of this nature were made by the British African Land Utilisation Conference in 1949, and in a subsequent report on the problems in the mechanisation of native agriculture in tropical Africa. But the committee will not confine its attention to Africa, since the mechanisation problem is one in which all Colonial territories have an interest. Its terms of reference are, therefore, "to keep under review the development of the mechanisation of agriculture in Colonial territories; to stimulate trials of existing kinds of agricultural machinery, and to encourage the manufacture of new machines." Mr. C. G. Eastwood, an Assistant Under-Secretary of State of the Colonial Office, is chairman of the committee, the membership of which includes: Colonel Philip Johnson of Roadless Traction, Ltd.; Mr. F. Meadowcroft, Morris Motors, Ltd.; Mr. H. E. Ashfield, David Brown Tractors, Ltd.; Mr. S. J. Wright, Ford Motor Company, Ltd.; Mr. A. B. Lees, Harry Ferguson, Ltd.; Mr. G. B. W. Schofield, Ransomes, Sims and Jefferies, Ltd.; Captain E. N. Griffith, Rotary Hoes, Ltd.; Mr. A. C. Nicholson, W. N. Nicholson and Sons, Ltd.; Mr. J. Cromar, Jack Olding and Co., Ltd.; Mr. W. J. Beith, Massey Harris, Ltd.; Mr. H. J. Lloyd, British Agricultural Machinery Manufacturers' Association; Mr. R. Gresham Cooke, Society of Motor Manufacturers and Traders; Mr. W. H. Cashmore, National Institute of Agricultural Engineering, and Mr. J. W. Y. Higgs, Reading University

Radio Research

WORK done during 1950, by the Department of Scientific and Industrial Research, on radio propagation, direction finding, radio noise and semi-conducting materials, is described in a report, *Radio Research*, 1950, published (price 1s. 9d.) by H.M. Stationery Office. The report shows how experimental work on the effect of conditions in the lower atmosphere on v.h.f. radio transmissions has been done side by side with theoretical methods of estimating the relative importance of such conditions as continuous refraction, reflection at temperature inversions, and the presence of turbulent eddies in the atmosphere. Conditions affecting transmission through the ionosphere have also been studied. An important factor in this field is the absorption of energy of radio waves during reflection from the ionosphere. This absorption varies with time of day and with season, the seasonal variation in high and medium latitudes being consistent with the diurnal changes in summertime, but anomalous in the winter. The variation of absorption during a solar cycle has been observed to be much smaller during the winter than at other times. The level of noise caused by atmospherics has been investigated since it has an important bearing on high-frequency transmissions. In addition, the waveforms of atmospherics have been examined partly to discover whether the waveform provides a reliable guide to the distance at which the atmospherics originate. Noise generated in the components of the receiving set itself has also been studied, as this noise may seriously limit the efficiency of the set. The mechanism by which the ionosphere introduces errors in high-frequency direction finding has been investigated. By using direction-finding stations capable of measuring the elevation angle and azimuth of the incoming wave, it has been possible to note the magnitude and direction of the slowly varying apparent tilt of the reflecting layers in the ionosphere. Directional errors attributable to objects near the receiving station and to ground reflections along the path have been observed. A large part of the work on semi-conducting materials carried out at the Radio Research Station was a detailed examination of the properties of germanium and of diodes and triodes made from it.

The Coal Utilisation Council

AT a meeting of the Coal Utilisation Joint Council, which was held in London last week, it was decided to revert to the pre-war title of "Coal Utilisation Council." Mr. J. Stanleigh Turner was re-elected president for the fourth successive year. In an address, he urged members of the Council to "resist strongly any attempt to use the results of their work as an excuse to reduce still further the already meagre allocation of coal to the domestic consumer." Mr. Turner said that the Council's success should become measurable in terms of the indirect saving of coal by the reduced use of gas and electricity for the main space and water heating loads, and he emphasised the need to encourage research into the smokeless burning of coal in domestic appliances. Another problem which, Mr. Turner said, still had to be overcome was the shortage of appliances and the need to ensure adequate supplies of raw materials for their manufacture. He also referred to the fact that, during the past two years, the Council had set up committees to assist in defining policy on such matters as smokeless zones, and the testing and certification of appliances. Mr. Turner added that, while encouraging the coal and appliance trades to give better service to the public, the Council fully recognised its responsibility to assist with training. He mentioned that the training centre, which had been started two years ago as an experiment only, had been so successful that larger premises for it were now being sought.

The British Steel Founders' Association

AT the recent annual meeting of the British Steel Founders' Association, Mr. T. H. Summerson, chairman and joint managing director of Summerson's Foundries, Ltd., Darlington, was elected chairman. Mr. Summerson is a grandson of the founder of the business, which was started in 1840, and which he joined in 1922. He represented his company at meetings of the former General Steel Castings Association, and was subsequently appointed to a committee whose report provided the framework for the British Steel Founders' Association, which was formed in 1944. Since its establishment, Mr. Summerson has been a member of the executive council and chairman of the publicity committee. Later, he was appointed chairman of the Development Committee, and was elected vice-chairman of the Association two years ago. During the war, Mr. Summerson was Director for Steel Castings in the Iron and Steel Control of the Ministry of Supply. He is a member of the Development Areas Treasury Advisory Committee, and has recently become chairman of the North-East Coast Association of Steel Founders. In addition, Mr. Summerson is a member of the Aycliffe Development Corporation, a member of the executive council of the Association of British Chambers of Commerce, the immediate past-president of the Tees-side Chamber of Commerce, and a vice-chairman of the North-East Development Association.

A Research Fellowship in Aeronautics

PARTICULARS have been announced this week of a new research fellowship, valued at £500 a year, for the study of advanced problems concerned with aeronautical engineering and design, which has been established at Glasgow University by the English Electric Company, Ltd. Under the supervision of Professor W. J. Duncan, F.R.S., Mechan Professor of Aeronautics and Fluid Mechanics at Glasgow University, holders of the fellowship will investigate problems related to the vibration, stability and control of aircraft. An indication of the importance of these aspects of research is the fact that the structural design of the wings and control surfaces of modern aircraft are now largely governed by the need to avoid "flutter" and other aero-elastic troubles. Fellows will be appointed by a board constituted by the University of Glasgow, and the first holder is to be selected early in the New Year. Professor Duncan, who will direct the work of the fellows, was Professor of Aerodynamics and Deputy Principal of the College of Aeronautics, Cranfield, from 1945 to 1949. Prior to that he was Wakefield Professor of Aeronautics in the University College of Hull, and also served at the Royal Aircraft Establishment at Farnborough. He was appointed to the new Mechan Chair of Aeronautics and Fluid Mechanics at Glasgow University in the summer of 1949.

P. and O. Line Commodore

LAST Friday, December 21st, Captain G. S. Stable, the Commodore of the fleet of the Peninsular and Oriental Steam Navigation Company, retired, and is succeeded by Captain H. S. Allan, R.D., R.N.R. Captain Allan, who was born in Ayrshire, Scotland, after serving his apprenticeship, joined the P. and O. Company in 1913 as fourth officer of the "Palma." During the first world war he joined the Royal Naval Reserve with the rank of Sub-Lieutenant, and served in minesweepers in the North Sea and North Russia. On his demobilisation in 1919, Captain Allan returned to duty with the company as third officer, and twenty years later was given command of the "Mooltan." His ship was requisitioned as an armed merchant cruiser on the outbreak of the second world war, and he took command of H.M.S. "Adrian." After a refresher minesweeping course, Commander (N.) Allan proceeded to Vancouver to supervise the fitting out of a flotilla of "Bangor" class minesweepers, with which he returned to England. In 1942 he was promoted to Captain R.N.R. and Acting Commodore, Second Class, and as such served in the North Atlantic convoys. A year later he was appointed to command H.M.S. "Largs," which acted as a headquarters ship at the Normandy landing and also the South of France landing. In command of H.M.S. "Artifex," Fleet Repair Ship, he served with the British Pacific Fleet from 1945 until his return to England a year later. On rejoining the P. and O. Company, Captain Allan spent a few months in command of the cargo ship "Palana," before being appointed to the "Strathaird," which he has continued to command.

Hydro-Electric Power in the Isere Catchment of the French Alps

No. VI—THE UPPER ISERE

(*Concluded from page 794, December 21st*)

MALGOVERT power station is the first of the series of developments below Tignes and Les Brevieres which will utilise the regulated flow of the Isere provided by Tignes dam. It consists of a barrage and intake works at the level of the tail-race of Les Brevieres power station (1557m) with a storage capacity of 180,000 cubic metres (150 acre-feet); a tunnel 15km in length under the left bank of the Isere; a surge chamber and steel-lined tunnel terminating in a valve house; two steel penstocks, each 2·2m in diameter and 1470m long, and the power station, from which the diverted water flows back into the Isere.

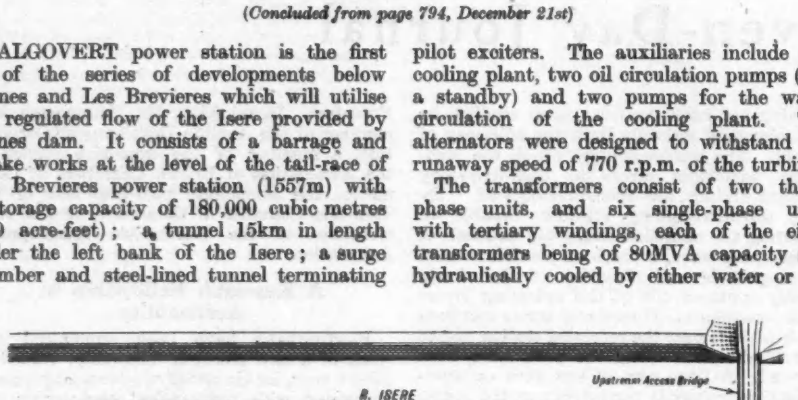


FIG. 36—MALGOVERT POWER STATION

The power station is thought to be the largest Pelton-wheel-driven installation in Europe, and will produce about 800 million kWh of firm power annually. It contains four turbo-alternator sets, each of 70·4MW capacity; its general lay-out is shown in the accompanying plan and cross section (Figs. 36 and 37). Each set consists of two double-jet Pelton wheels driving an alternator mounted between them. The eight Pelton wheels are thus each of 52,500 h.p.; they will normally run at 428 r.p.m., the set being designed so that should the full load be suddenly shed completely, the speed will not increase by more than 20 per cent. The runaway speed will not exceed 770 r.p.m. Each turbine has its own inlet pipe with a spherical valve to control the flow. The normal flow through the power station at full load will be 45 cubic metres per second (1590 cusecs).

The alternators are totally enclosed and self-ventilated and are each supported on two overhung bearings, with the turbine runners mounted at each end of the shaft. They will generate 80MVA continuously at 428 r.p.m., with a nominal power factor of 0·88. The generated voltage will be 10·3kV, regulated between the limits of ±5 per cent. The main exciter is mounted between the rotor and one of the bearings, and is of 265kW at 265V; there are two pilot exciters. The auxiliaries include air-cooling plant, two oil circulation pumps (one a standby) and two pumps for the water circulation of the cooling plant. The alternators were designed to withstand the runaway speed of 770 r.p.m. of the turbines.

The transformers consist of two three-phase units, and six single-phase units with tertiary windings, each of the eight transformers being of 80MVA capacity and hydraulically cooled by either water or oil. The three-phase transformers have the primary windings delta-connected, with star-connected secondaries, and will transform from 10·3kV to 223kV. In the case of the single-phase transformers, each primary winding is designed for a power of 26·6MVA at 10·3kV, with provision for delta connection. Similarly, the secondary and tertiary windings also have provision for star connection. They transform to 150kV and 236·3kV respectively.

The system of protection of the power station is similar to that employed at Les Brevieres power station; all faults which can occur on the turbo-alternators, transformers, or the various circuits and ancillaries, both electrical and mechanical, will be signalled by a bell, for minor faults not involving load shedding or stopping the machines, and by a Klaxon for more important faults. Also, a luminous signal will be given on the control board to indicate the nature of the fault.

The switching station is on the opposite side of the River Isere from the power station, the upstream bridge shown in Fig. 36 carrying the cables. Considerable excavation was necessary to form the large flat area that was required for its construction. A diagram of the transmission lines passing through Malgovert switching station is shown in Fig. 38. Fig. 39 shows diagrammatically the principal transmission lines in the area of the Isere catchment and will be of interest with reference to the schemes described in the previous parts of this article, as well as with regard to Malgovert power station itself. Fig. 38*a* shows the present arrangement at Malgovert with two 220kV lines going out to Genissiat, and one to Italy; the sketch *b* shows the future arrangement whereby the two 220kV lines will be replaced by a single line at 380kV and the switching station has been laid out with the development in view. The 380kV line will utilise the same pylons as those at present employed for the 220kV lines and will consist of three lines, each being a double conductor. This arrangement, which reduces losses due to skin effect at 380kV, will allow the 220kV cables to be used at 380kV by grouping them in pairs; thus the 380kV line will be put into service without dismantling the 220kV lines.

The power station building is of reinforced concrete, 125m by 48m, and 18m in height. It is built on the left bank of the Isere, which was diverted during its construction and which has been made to flow parallel to the power station, as shown in Fig. 36, between river walls through a channel designed to avoid scouring from the turbine discharges or from river floods. A large washing, crushing and screening plant, and a central volume batching and mixing station, supply all the concrete required. Aggregates for the mass concrete work were dragged from the river bed just downstream, and cement brought on the monocable supplying Tignes dam, which passes by the power station site. For the higher quality concrete required in the heavily reinforced parts of the power station, however, graded aggregates were brought from quarries at Pontcharra-sur-Bréda.

THE TUNNEL INTAKE

The barrage forming the reservoir at the start of the Malgovert tunnel was built in 1934; at the time it was intended to develop the Isere from that point as far as

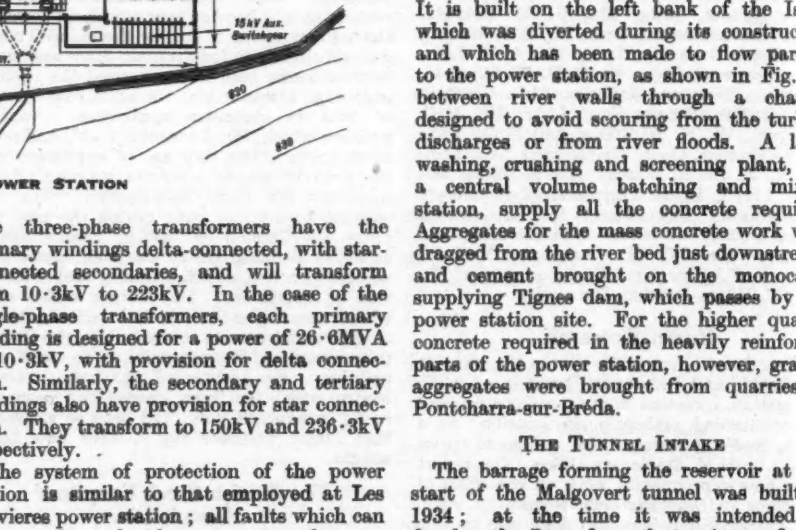


FIG. 37—CROSS SECTION OF MALGOVERT POWER STATION

the intake of the scheme at Viclaire (see Fig. 29), which was built in 1925, by constructing the Gurraz tunnel and power station; however, only the barrage was built in 1934 and the tunnel intake in 1936. It makes an interesting comparison of the progress in hydro-electric design, to contrast the extent of the present-day schemes with these earlier ones. Viclaire power station has an installed capacity of 40MVA, with four sets, and its annual production of power is at present about 199 million units, utilising a flow of 10 cubic metres per second; when the new schemes come into operation the installed capacity and power production will be reduced to 20MVA and 40 million units respectively. At the time it was built Viclaire power station was a very good example of the most modern hydro-electric design. The gross head of the scheme is 400m, the level of the tunnel intake being 1290 N.G.F. For the Gurraz power station it was intended to utilise a head of about 250m up to the reservoir level of 1557; the Malgovert power station, by contrast, makes use of the same intake, at 1557 N.G.F., and has a tail-race level of 807, involving far more ambitious diversion works, with a tunnel 15km long and twin penstocks of modern design for a normal flow of 45 cubic metres per second. Such a project has been made economically possible by improved techniques and by the provision of seasonal storage in the Tignes reservoir.

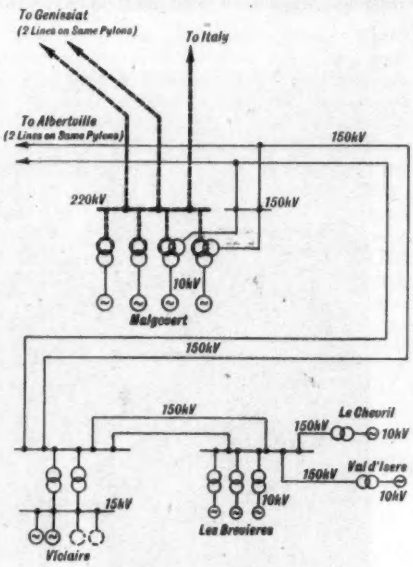
The barrage at the tunnel intake mentioned above is a structure with three bays, two of 5m span and one of 2m. Each bay is closed by a pair of sluice gates arranged with the smaller gate above the larger, to facilitate discharge control. The sluice gates are controlled from a covered bridge extending across the barrage. A flood of 186 cubic metres per second can be discharged by the barrage without elevation of the reservoir level. The intake works consist of screens, a sedimentation chamber, and then fine screens and sluice valves at the tunnel entrance itself, which was built in 1936 for a flow of 30 cubic metres per second, and has been enlarged for a capacity of 50 cubic metres per second. Since 1934, when the barrage was built, although not used for its original purpose, it has provided a useful storage reserve for the operation of Viclaire power station.

Malgovert Tunnel

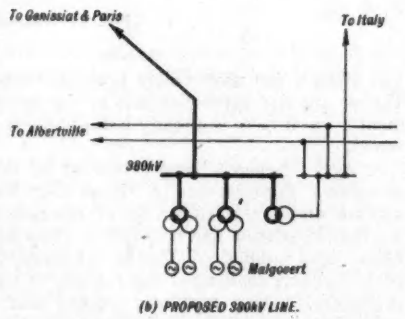
Work on the Malgovert tunnel was first started in 1939 (with the exception of a short length built with the intake in 1935) and has been proceeding since that date, with the exception of a break of about five months at the outbreak of the war. Two tunnel sections have been employed—a horseshoe section of 16·38 square metres in good rock and a circular section of 16·25 square metres in bad rock (diameter 4·55m)—and the tunnel will be lined with concrete for its entire length. As may well be imagined, a wide variety of tunnelling methods have been employed during the course of the work; recently some of the most modern plant has been used, both for the excavation and the concrete lining.

Fourteen adits have been driven to the tunnel at various points along its length. In general, the adits are somewhat inaccessible; they are situated on the left bank of the Isere at varying elevations up steep slopes; the main road runs along the right bank. The surge shaft and last adit have road access, the road having been widened and made accessible, with difficulty, to lorries. Adit No. 13, close to which is an aggregate plant, cement silos, and so on, is accessible by "jeep road" only; it is, however, supplied with cement by a branch cableway from the Bourg St. Maurice-Tignes monocable. Aggregates for the tunnel concrete are crushed and graded at the site.

The tunnel driving has been carried out without serious difficulty with two exceptions. At the adit No. 13, when driving the pilot tunnel in the upstream direction, a zone of broken quartzites was encountered, causing granular material and water to run into the tunnel, and necessitating heavy timbering. A second adit was driven, with the idea of



(a) ARRANGEMENT OF 220kV LINES.



(b) PROPOSED 380kV LINE.

FIG. 38—TRANSMISSION LINES FROM MALGOVERT

driving further into the mountain and diverting the tunnel round the zone of bad rock. After considerable exploration, however, it was found that the tunnel would have to pass through the deteriorated zone for a certain length. A further adit, No. 12, was therefore driven clear of the upstream side of the bad rock, which was pierced by injecting with silicate and cement, metre by metre, to solidify the mass of the broken quartzite.

The second serious difficulty was encountered 700m upstream from the surge shaft, where a powdered material "milonite"—which is formed by the decomposition of schist—ran into the tunnel. Steel ribs placed side by side still gave insufficient support for the tunnel, the line of which had to be changed to avoid the bad zone.

Much of the recent work of placing the concrete lining has been carried out with concrete pumps. At adit No. 13, which was mentioned previously, the concreting plant is similar to that which was used for the Cordeac tunnel (described in Part IV). Dry batches of aggregate and cement are measured into skips, which are then driven to the concreting station. Mixing and placing is carried out in one operation by a compressed air machine, known as a "Johnny." The skip is hoisted up and its contents emptied into the hopper of the "Johnny"; compressed air and water are then added in the mixing chamber and, after a mixing time of forty to fifty seconds, the mix is shot into the shutter. The entire circumference, except, of course, the invert, is concreted in one operation over a length of about 30ft, using steel shutters. The "Johnny" in use in the Malgovert tunnel has a capacity of 250 litres.

The surge shaft has an inside diameter of 18m and is lined with a concrete lining 1m thick. It is vertically above the tunnel from which it is separated by a throat, and it is about 50m in height from the tunnel invert. The top of the shaft is open at ground level and for the top 5m of its height its diameter increases from 18m to about 30m. It is shown under construction in Fig. 40.

Downstream of the surge shaft is a steel-lined tunnel, 305m long and 3·2m in diameter, terminating in a bifurcation at the valve house; the steel lining was placed in hoops 9m wide and 10mm to 12mm thick (the thickness of the bifurcation is 18mm), which were butt-welded together with an outside cover strap. The valve house is of reinforced concrete and contains two butterfly valves, one for each of the two penstocks. It forms the top anchor block for the pipeline, the centre line of the valves being at a level of 1492 N.G.F.

Penstocks

The two penstocks have been positioned in a trench dug down the mountainside of the Malgovert forest. They have an internal diameter of 2·2m, reducing to 2·1m at the lower end, and are 1727m and 1740m in length, respectively. Close to the power station there is a main bifurcation and two secondary bifurcations on each penstock, to give a supply to each of the eight Pelton wheels. The pipes have been built by the autofrettage process. They have a maximum length of 10m and consist of a sheet steel cylinder with a thickness varying between 10mm and 17mm, according to the position in the pipe-line, the strength of the sheet steel being 54kg per square millimetre; in the upper part of the pipe-line, where the diameter is 2·2m, the pipes are wound with steel cables, with a strength of 200kg per square millimetre, and in the lower part, where the diameter is 2·1m, laminated hoops of steel (strength 115kg per square millimetre) replace the cables. All site joints were made by butt-welding, with outside cover straps. The autofrettage process consists of placing the hoops or winding round the pipe, and then stressing it beyond its elastic limit by internal pressure from a hydraulic press.

The pipes rest on concrete supports, with metallic cradles, and there are sixteen anchor blocks, including the valve house and the power station itself; as is usual with French practice, there are no expansion joints.

The Malgovert penstocks provide a good example of modern French technique in this field; the autofrettage method was developed by the Etablissements Bouchayer et Viallet, the first example being constructed in 1928. Since that date, however, many advances have been made in penstock construction. An interesting comparison has been given by Monsieur Ferrand*, who has pointed out that for the power station of Eget, in the Pyrenees, which was built in 1922, seven pipe-lines were necessary to

* "La Houille Blanche," May-June 1949. This issue is entirely devoted to problems of the design of penstocks.

carry a flow of 5·3 cubic metres per second, under a gross head of 750m (2460ft). At Malgovert, where the head is the same, two pipe-lines carry 50 cubic metres per second, or about 200,000 h.p. each. The capacity of the pipe-line depends on the strength of the hydraulic press employed to prestress it; a 7000-ton press was used by the Etablissements Bouchayer et Viallet to make the Malgovert penstocks. With this press it is possible to build a pipe-line with a capacity of 250,000 h.p. if it is uncovered, or 500,000 h.p. if it is buried. These figures correspond to heads of 870m and 1750m, for an uncovered and a buried penstock respectively, each of 1·5m in diameter and carrying a flow of 13 cubic metres per second. Higher capacities would be possible with a more powerful press, but in that case the design of the bifurcations would become excessively difficult or even impossible to construct. In fact the bifurcations on the Malgovert pipe-lines have been specially studied; a cross section of one of them is shown in Fig. 41. The weight of the penstocks at Malgovert is about 4450 tonnes; at Eget, the seven lines of pipes and their accessories weigh 2450 tonnes, which is about 5·5 times as great, in relation to the power transmitted.

Auto-fretted pipe-lines have been employed for the various high-head schemes mentioned in this article. An early example is that of Bissorte, in the Arc Valley, which was built in 1932, where a single pipe-line transmits 100,000 h.p. under a head of 1200m. In the same valley the penstock of the Aussois pipe-line transmits about the same power under a gross head of 860m.

Some Administrative Problems

The problems connected with the Tignes-Brevieres-Malgovert development have not all been technical ones, such as those outlined in the preceding paragraphs. There is frequently controversy about the social effects of hydro-electric schemes and the proposals for the Tignes reservoir gave rise to a particularly acute problem in this respect. The valley which will be flooded is a very pleasant one, as may be seen from Figs. 30 and 31, and the village of Tignes, with about 300 inhabitants, is in the centre of it. It has been necessary to settle all these inhabitants in other dwellings. Where mutual agreement permitted, small agricultural holdings were found in other valleys to replace those to be submerged in the reservoir, but a new village of Tignes is in the course of construction. A replica of the village church, to which all the interior decorations will be transferred, is under construction near the Plateau des Boisses, close to the left abutment of the dam. A new village will be built partly around it and partly close to the Lac de Tignes, which is situated behind the hills forming the left bank side of the reservoir site. Road access will be provided and it is intended to make Lac de Tignes a centre for winter sports. Other buildings have been constructed in the Val d'Isere, the next valley upstream from Tignes and the uppermost one in the catchment. Val d'Isere is already well known as a resort.

A legal "impasse" was produced by this situation. Construction of Tignes dam was started under the authority of emergency wartime legislation and no public inquiry was held. The council of Tignes subsequently protested and challenged the validity of this procedure. Their case was upheld and a public inquiry was then called for. Until the result of this inquiry was announced it was not known whether legal sanction of the work would be forthcoming.

Another aspect of the work which has been very extensive has been the construction of what are generally listed as "ancillary works." Many miles of access roads have been built or widened to give access to the dam, the power station, surge shafts, adits, and so on. The main road to Bourg Saint Maurice has been widened and tunnels on it enlarged and bridges strengthened so that heavy pieces of machinery, too large to be carried by rail, can be brought to Malgovert.

Fig. 40—Malgovert Surge Shaft

The rotors, for instance, of the alternators are 9m long and 3·60m high, weighing 160 tonnes; they will be carried on a special vehicle with forty-eight wheels and hauled by four tractors, the 600km journey from Belfort to Malgovert taking thirty-five days. The stators are 5·2m high and weigh 105 tonnes, and the transformers are about the same height, weighing 140 tonnes. At the dam site the R.N. 202 had to be rebuilt at a high level to skirt the reservoir. At Bourg Saint Maurice a railhead was constructed to accommodate the cement silos referred to in the section on the Tignes dam, and various other facilities. Lastly, houses for the power station staff, which are at present occupied by engineers engaged on the constructional work, have been built, notably at Seez. This accommodation is of very pleasant and up-to-date design.

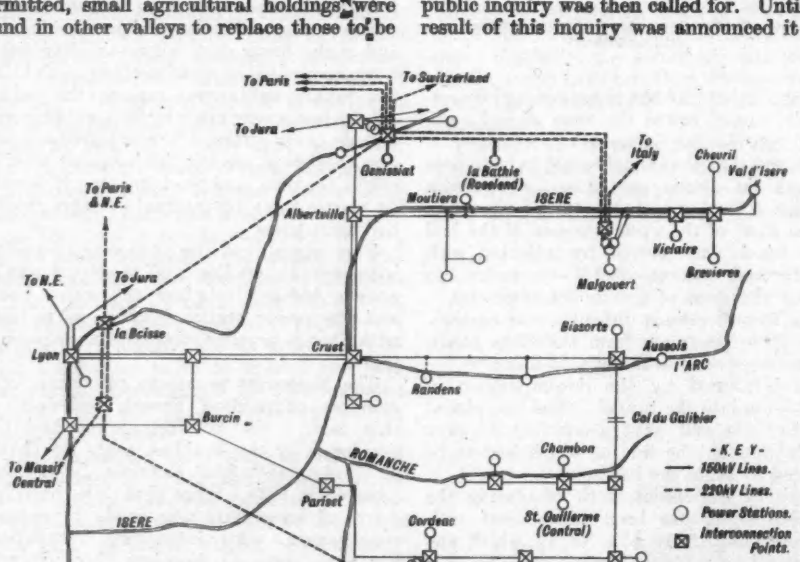


Fig. 39—150kV and 220kV Network of the Northern Alps

Progress

By the end of the summer season of this year about 400,000 cubic metres of concrete, out of a total of 650,000, had been placed in the dam at Tignes. The building work for Les Brevieres power station is now complete and installation of the first turbo-alternator set was started last month. It is expected that water will be stored in the lower part of Tignes reservoir by next spring, and the first machine at Les Brevieres turned round by October, 1952.

Excavation in the Malgovert tunnel is substantially completed and emplacement of the lining is well advanced. Malgovert power station has been built and the first four turbines are being installed, together with various auxiliary services and electrical apparatus. It is thought that the first turbo-alternator set will be in operation next July, and the second set in October. The entire

Tignes - Brevieres - Malgovert development will, it is thought, be in full operation by late in 1953.

The Isere-Arc Project

In Part V of this article an outline was given of the proposed development of the Upper Isere, from which it may be recalled that the forebay of a large power station at Moutiers will be built just downstream of Malgovert power station. Some trial explorations and preliminary works have already been carried out for this scheme and the main works will probably be started in 1954. Continuing the development downstream is the Isere-Arc diversion, which utilises the difference in level between the Isere and the Arc at this point with a power station at Randens. Work on this project is still in the early stages, but it is expected that some interesting experience in tunnel

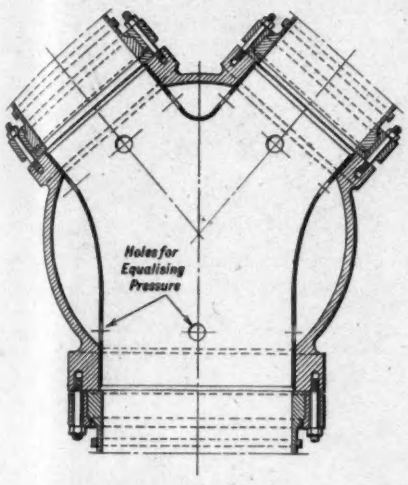


FIG. 41—DETAIL OF PENSTOCK BIFURCATION

driving will be gained as the work proceeds. The tunnel is to be driven under a maximum overburden of 6500ft, with one length of 1½ miles without intermediate access.

The scheme consists essentially of a dam forming a reservoir of 325 acre-feet capacity on the Isere downstream of Moutiers intake and diversion works, partly in open cut and partly in tunnel, totalling some 10 miles in length; and then a surge shaft, followed by a pressure shaft leading to an underground power station, followed by a long tail-race channel into the River Arc. There will be four vertical Francis turbine sets, each of 35MVA capacity, working under a gross head of 153m and producing about 450 million kWh annually. Each of the reservoirs of Tignes and Champagny represent a reserve of about 75 million kWh for this project alone.

Some of the more unusual details of the project include the arching of the dam, in a vertical plane, across deep alluvial deposits which will be rendered watertight by grouting. The surge shaft will probably be the largest so far constructed and will consist of a shaft 15·5m in diameter and 50m deep, with five horizontal expansion chambers spaced around its upper part. The tunnel will in general be of horseshoe section, 6m in height; it is being excavated by mechanical methods employing full face working, in general with a jumbo mounting sixteen light drills at two levels and drilling seventy-five holes, with a pull of about 3m. After blasting the spoil is loaded into wagons by two Conway loaders working side by side. In the centre of the tunnel the conditions met with in the large trans-Alpine tunnels, such as Mont Cenis, Simplon and Loetschberg, will be encountered, necessitating rapid emplacement of the tunnel lining to avoid movements due to the great pressure of the overburden, and extensive air conditioning with refrigeration plant. It is estimated that the temperature of the rock will be as high as 37 deg. Cent. and will be in excess of 35 deg. Cent. for 2km of the tunnel. At present only a small portion of the tunnelling has been completed and the critical length remains to be driven.

Potentialities of the Catchment

The somewhat extensive survey which has been given in this article will, it is hoped, give an idea of the variety of developments which are in progress in the Isere catchment and of the possibilities and problems peculiar to that area. As mentioned in the introduction, 4210 million units of electricity were generated in the catchment during 1950; that figure will be substantially increased year by year, until a production of the order of 10,000 million units is reached when the area will be substantially fully developed. The various schemes described in the foregoing paragraphs are of considerable magnitude and complexity, and their achievement reflects great credit on the skill of the various French engineers and firms who have been responsible for them. France's power supplies will be largely derived from such sources in the future, for development is also in progress in other areas. In the Alps themselves, the Durance catchment is potentially of comparable magnitude with the Isere, and there are several smaller rivers, such as the Arve, which drains the north-western part of the Mont Blanc massif and flows into Lake Geneva, and several streams in the Alpes Maritimes. The development of the Rhone and the Massif Central have been referred to earlier in the article, and a great deal of work is also in progress in the Pyrenees.

Owing to the numerous schemes which have been mentioned, it has unfortunately not been possible to mention the names of the various firms concerned with them, except in one or two cases. The design of hydraulic works in France is under the control of the Directeur de l'Equipement of Electricité de France. Most of the new works mentioned in this article have been designed by the Region d'Equipement Hydrauliques Alpes I, which is under the direction of Monsieur Ligouzat; some of the works, however, notably those in the Arc Valley and the Isere-Arc diversion, are being carried out under the direction of the Region d'Equipement Hydraulique Alpes II, for whom the chief engineer is Monsieur Chapoutier. Our thanks and acknowledgments are due to the first mentioned of these authorities, whose co-operation has made this article poss ible.

Pneumatic Handling of Flour Mill Stocks

By B. FRANCKE

FROM the earliest days of automatic flour-milling the movement of stocks between processes has been mainly vertical. The stocks have been lifted by elevators to the top of the mill and allowed to fall down spouts to successive processing machines on successively lower floors. The first floor of the mill is usually the lowest of the machine floors, and usually has the roller mills on it. Stocks fall to the roller mills from sifting machinery on higher floors. From the roller mills they fall to elevator boots on the ground floor, and are elevated to the top of the mill again. Flourmilling is a process of repeated grinding and sifting, and in general stocks will travel up and down the height of the mill once for every time they are ground. Of course, stocks may have to be moved laterally as well as vertically, but mill plants are so arranged, if possible, that stocks do not have to be moved laterally further than they can be carried by sloping the spouts. They cannot be carried very far by that means, because they will not fall freely unless the spouts slope fairly steeply. Horizontal conveyors of various kinds are used if stocks have to be moved laterally further than sloping spouts can carry them.

Until quite lately mechanical elevators have been universally used for elevating mill stocks. Bucket elevators, with their buckets mounted on belts, have been the commonest kind.

The possibility of a pneumatic handling system to replace the mechanical elevators has been considered by milling engineers for a long time. They were familiar with many of the problems involved, partly because pneumatic ship-discharging plants had long been used for unloading wheat at port flour mills, and partly because all flour mills apply forced ventilation to some of their machines. The design of these ventilating or "exhaust" systems calls for study of the problems of moving air through pipes.

There were many potential advantages that made the pneumatic system attractive. The cost of the installation (and of installing it) seemed likely to be lower than the cost of a mechanical elevator system, and its maintenance costs seemed likely to be much lower. It seemed that the conveying air might be used to replace the normal exhaust system, at least on the roller mills, and perhaps on some of the sifting machines. The installation and power costs of those parts of the exhaust system might thus be saved. Because the pneumatic installation would be more compact than bucket elevators, it would be possible to house a milling plant of a given capacity in a smaller building. Finally, a pneumatic handling system should be far less liable than bucket elevators to insect infestation.

Against all these attractive possibilities there were two disadvantages to be feared: that the power costs of the pneumatic system would be high, and that the conveying air would evaporate too much moisture from the stocks (a serious matter for the miller, for he sells his flour by weight).

It is not surprising that some of the first full-scale experiments in the pneumatic handling of mill stocks were made in countries where water power was plentiful and some extravagance of power could be tolerated. The experiments showed that the forecasts of high power consumption had been right, and in some of the early installations evaporative losses, too, were found to be greater than they normally were in mills with mechanical elevators. But it was not only the expected disadvantages of pneumatic handling that materialised in these early experiments; the potential advantages were also realised to the full. It soon became

clear that some millers were willing to accept even the high power costs for the sake of the general attractiveness of the pneumatic system, and their interest naturally prompted the milling engineers to make great efforts to overcome its disadvantages.

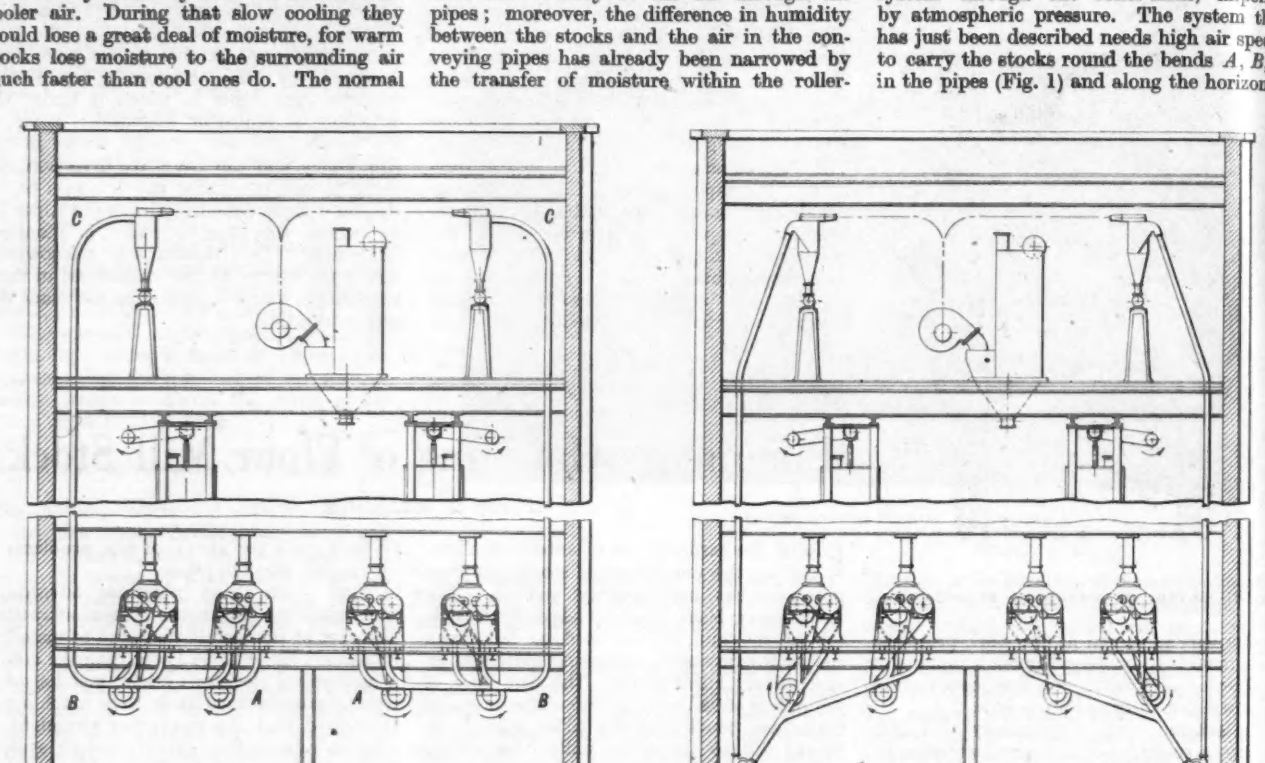
The problem of evaporative loss soon proved to be less serious than some early experience had suggested. The ultimate cause of evaporative loss is the heat that grinding generates. If no steps were taken to dissipate that heat, even mills that used mechanical elevators would experience high evaporative losses. The roller-mills themselves and the stocks they were grinding would both get much warmer than they should, and the stocks would be left warm, to be slowly cooled by more contact with the cooler air. During that slow cooling they would lose a great deal of moisture, for warm stocks lose moisture to the surrounding air much faster than cool ones do. The normal exhaust system that flour mills with mechanical elevators apply to their roller-mills is designed to cool both the stocks and the roller-mills and so to minimise evaporative losses and bring the stocks to a condition suitable for sifting processes. It is true that the air current drawn through the stocks increases the rate of evaporation from them slightly, but it quickly cools them to a temperature at which they will lose very little more moisture in still air. The evaporative loss that the exhaust air causes will be reasonably small unless the exhaust air is warm or is much drier, initially, than the stocks themselves. It had been feared that the pneumatic handling system would increase evaporative losses because it would draw more air through the stocks than the normal exhaust on roller-mills would, and because the stocks would spend longer in contact with the conveying air than with the air of the normal exhaust system. Curiously enough, these two differences are found to largely offset each other if conditions of air temperature and comparative humidity are satisfactory. Because the pneumatic system uses more air, it cools both the stocks and the roller-mills more thoroughly and, if it evaporates more moisture from the stocks in the process, they lose less moisture later because they are cooler. It seems certain that the more thorough cooling of the roller-mills themselves must reduce significantly the highest temperature that the stocks ever reach during grinding, and that must directly reduce evaporative losses. The balance of advantage within the roller-mills themselves seems to be sufficiently in favour of the pneumatic system to offset what it loses by the longer contact between stocks and moving air. It is worth noting that the stocks themselves move fast through the pneumatic conveying pipes and so the relative velocity of the stocks and the air will be very much less than the velocity of the air through the pipes; moreover, the difference in humidity between the stocks and the air in the conveying pipes has already been narrowed by the transfer of moisture within the roller-mills: These considerations may explain why in practice pneumatic handling installations have not suffered generally from the high evaporative losses that were expected.

The problem of high power consumption proved a more obstinate one and is still a handicap to pneumatic handling systems built to the earlier designs.

In those earlier designs the stocks are led downwards from the roller-mills into horizontal pipes immediately beneath the roller-mill floor. The horizontal pipes carry the stocks to the sides of the building and there curve upward and lead vertically to the top of the mill; there they curve again and lead horizontally into the cyclones that separate the stocks from the air. Cyclones of the small diameters used for this purpose can be highly efficient separators. They can remove from the air more than 99·8 per cent (by weight) of the stock entrained in it. The stocks are discharged from the cyclones into spouts that lead to the sifting machines. Each cyclone discharges through a rotary seal—a horizontal cylinder, with radial pockets in it, which fits into a cylindrical case and revolves in it. Successive pockets register in turn with ports at the top and bottom of the case. Stock falls from the cyclone through the upper port into the pockets of the seal and then from the pockets through the lower port into the spout.

The conveying air passes from the cyclones to the centrifugal fans that are used to move it. The fans blow it to textile-filter dust collectors, which remove from it the small amounts of stock that escape the cyclones. The filtered air is perfectly clean and may be allowed to escape to the atmosphere either inside or outside the mill building—but if it is released outside, the pressure within the mill will be lowered and air from outside will flow in.

The conveying air enters the pneumatic system through the roller-mills, impelled by atmospheric pressure. The system that has just been described needs high air speeds to carry the stocks round the bends *A*, *B*, *C* in the pipes (Fig. 1) and along the horizontal parts of the pipes. Careful research has shown that it is through these parts of the system that the stocks are hardest to move. It was reasonably assumed that if these resistances could be removed, by the elimination of the bends and horizontal parts themselves, a system might be developed that would work satisfactorily with lower air speeds and correspondingly lower power consumption. A comparison between Fig. 1 and Fig. 2 shows how far the elimination of bends and horizontal pipes has proceeded.



FIGS. 1 AND 2—EARLY ARRANGEMENT FOR PNEUMATIC HANDLING (LEFT) AND MODERN LAYOUT (RIGHT)

In the earlier system shown in Fig. 1 each pneumatic conveying pipe begins immediately beneath the roller-mills and contains three 90 deg. bends and also a horizontal section, which will vary in length according to the width and the arrangement of the roller-mill floor.

In the later and more efficient system shown in Fig. 2 the conveying pipes proper are the ones shown at the sides of the mill, reaching from the bottom of the building to the top. The stocks are carried to the pick-up points for the pneumatic pipes by spouts from the roller-mill hoppers. The spouts need not slope steeply enough to move the stocks by gravity alone, for the conveying

air, drawn into the system through the roller-mills, flows with the stocks and helps to move them down the spouts. There may not seem to be much difference between these "gravity-assisted air spouts" (as the makers call them) and the corresponding parts of the pneumatic conveying pipes in the earlier system; but in fact the difference is important. The air need not move through the spouts at nearly such high speeds as are needed to move the stocks through the first bends and horizontal pipes of the older system. The spouts can accordingly be made larger in section (and so lower in resistance) than the conveying pipes, with the result that, whereas in the older system this first part absorbs a great deal of power, in the later system it absorbs very little. Of the spouts shown in Fig. 2 only the ones from

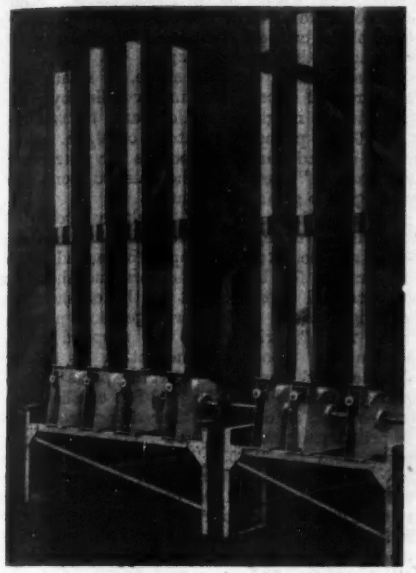


FIG. 3—LINE OF DIFFUSERS DRIVEN FROM A COMMON SHAFT

the two inner lines of roller-mills really need the help of the air to move the stocks. The spouts from the outer roller-mills are steep enough to move stocks by gravity alone; that is the most efficient arrangement of all and, of course, it can be used for all the roller-mills, in a narrower mill that only has two lines of them.

The most ingenious feature of the system shown in Fig. 2 is the device for negotiating the acute bend between the spouts from the roller-mills and the vertical conveying pipes. The makers call this device a "diffuser." It is simply an air-tight drum, which has inside it a rotor with radiating vanes. It serves for the pneumatic elevator very much the same purpose that the boot serves for a mechanical elevator: it presents the stocks to the elevator in such a way that the elevator can get hold of them. The spout from the roller-mill enters the diffuser drum tangentially and the elevator pipe leaves it tangentially. The air enters comparatively slowly through the large-section spout and its circulation within the drum is kept comparatively slow by the rotor vanes. The peripheral speed of the vanes is substantially less than the speed of the air in the elevator pipe. The stock in the diffuser is kept in suspension by the controlled circulation of the air until it is drawn into the elevator pipe. The diffuser has been found to be an efficient means of carrying the air and stock round a sharp bend, and by allowing one sharp bend in the system it has been possible to eliminate other serious bends completely. The diffuser rotors are power driven but in a well designed installation all the rotors on one side of the mill can be so aligned that one straight-through shaft can drive them all (Fig. 3) and the power needed to drive them is only of the order of one-thirtieth h.p. per rotor, however they are driven.

The special cyclones that have been developed for the new system also help to eliminate bends by means of their steeply sloping intakes (Fig. 4).

The total effect of these developments on the power consumption of pneumatic conveying systems can be seen in the following table, which compares the power consumed for all purposes by three milling plants, each with a different handling system.

*Power Consumption at Three Mills, Each Grinding 100 Tons of Wheat Per Day**

	Bucket elevator mill	Mill as Fig. 1	Mill as Fig. 2
	h.p.	h.p.	h.p.
Pneumatic conveying fans	—	90	30
Low-pressure fans	—	12	12
Bucket elevators	10	—	—
General exhaust on roller mills and plansifters	20	—	—
All other machinery (power consumption not affected by handling system)	155	155	155
Total power consumed by mill	185	257	197

* Figures by courtesy of Henry Simon, Ltd. They are to be regarded as average figures, liable to some variation with variations in the grist and in other conditions.

The most striking comparison in the table is the comparison between the powers that the pneumatic conveying fans need in the old system, shown in Fig. 1, and in the new system, shown in Fig. 2. The saving in the new system of two-thirds of the power that the old system required must be regarded as a remarkable achievement.

The comparison between the power consumption of the new system and that of the equivalent machinery in a bucket-elevator mill has to be made rather less directly to be fair. Although the actual elevators of the bucket elevator mill use only one-third of the power that the new-system pneumatic elevators use it must be remembered that the pneumatic elevators are doing—at no extra cost in power—the work of the general exhaust on the roller-mills and plansifters, which use twice as much power as the elevators do in the bucket-elevator mill. But it is fair to charge against both of the pneumatic systems the power consumed by the low-pressure fans that are used in both of them for exhausting the textile-filter dust-collectors. If the power used by these low-pressure fans is included the total power consumption of the new pneumatic system is seen to be roughly 40 per cent greater than the fairly comparable power consumption of the elevators, the roller-mill exhaust, and the plansifter exhaust, in the bucket-elevator mill. Two considerations help to put the importance of that difference in its proper perspective: first, the total power consumption, for all purposes, is only about 6 per cent higher in the new-system pneumatic mill than it is in the bucket-elevator mill, and, secondly, before the new pneumatic system was available many a miller was anxious to avail himself of the general advantages of pneumatic handling, even at the cost of raising the power consumption of his milling plant by almost 40 per cent.

Another considerable advantage of the new pneumatic system may be mentioned in conclusion. The older system was very vulnerable to choking if it was temporarily overloaded and it was almost certain to be choked if the mill was stopped suddenly, whether by intention or through a power failure. In any of those circumstances stocks were prone to lodge in the bends and horizontal parts of the pipes and when that happened there was no remedy but to dismantle the parts that were choked. The new system is much less prone to these troubles because there is no part of the conveying pipes or of the spouts that stocks will readily lodge in. If the air supply fails the stocks tend to fall from the spouts and conveying pipes to the diffusers and the diffusers automatically release overloads of that kind through flaps that are normally held closed against the edges of the diffuser drum by atmospheric pressure.

The new system is already at work or in the course of installation in more than twenty mills in many different countries and there is little doubt that improved pneumatic handling systems will in time replace the old mechanical-elevator systems.

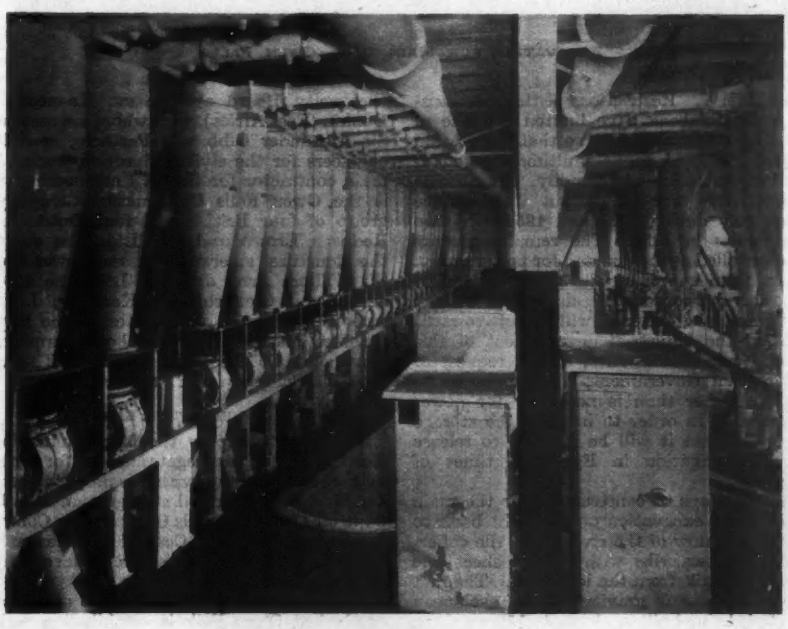


FIG. 4—CYCLONE INSTALLATION

Progress of the Owen Falls Hydro-Electric Scheme

IN our issue of July 9, 1948, an account was given of the proposed Owen Falls hydro-electric scheme in East Africa, on the White Nile, 2 miles downstream from Lake Victoria. Construction of the permanent works of this project, which is being built for the Uganda Electricity Board, was started in mid-1950, and it is now possible to give an idea of the progress up to the present time. Briefly, the scheme consists of a gravity dam 2725ft long, the maximum height of which is 85ft. Six control sluices, each 6ft 9in by 9ft 10in wide, which are to be constructed at the centre of the dam, will be capable of taking the maximum recorded flow of 43,000 cusecs. In addition to the main dam, there are two short dams forming the sides of the headrace channel to the power-house, and the intake dam immediately upstream of the power-house containing the control gates and screens for the turbines. The gross available head will be 63ft and, with an assumed average flow of 17,800 cusecs, regulated to give an annual load factor of supply of 60 per cent, the maximum output will be 135MW. Restrictions of the rail transport from Mombasa have limited the size of generating units to 15MW, so that the station has been designed to hold ultimately ten of these units, including one standby. Four turbo-alternator sets are to be put into service progressively during 1953 and 1954, and two further units in 1955. The remaining units will be installed as the demand for power grows.

Apart from supplying the growing demand for power by consumers already settled in this region, the scheme will assist towards increasing the industrial development of this part of East Africa. Also, at the request of the Egyptian Government, the dam is to be built 1m higher than is necessary for power requirements, in order to increase the storage capacity so that it will be possible to release water for irrigation in Egypt in times of drought.

The first stage of construction for the main dam involved excavation on the right bank to maintain the flow of the river while the coffer-dams of timber cribs with a steel sheet pile facing were built from the left bank. The first section of the main gravity dam of cyclopean concrete is being built in alternate 15ft sections, which, besides providing temporary openings for the river to pass through during the second stage, will allow for the contraction of the concrete on cooling. On the main dam concreting has been started and the placing of the cribs for the cofferdams is well under way, small sections of the river bed having been dewatered approximately twelve months ago. Our first illustration shows the excavation for the main dam, with a small cofferdam, and the crib-placing gantry on the right-hand side. It is anticipated that the water level will be raised in the early part of 1953.

In the case of the power-house construction, the cofferdam on the downstream side has been completed, while the rock excavation is well advanced for all ten sets. The concrete foundation for the first unit is complete, ready to receive the spiral casing of the turbine. Structural steelwork for the first three bays of the power-house has been erected and a start has been made on the erection of the 120-ton overhead crane. The illustration shows erection of the power-house steelwork in progress.

The consulting engineers to the Uganda Electricity Board are Messrs. Kennedy and Donkin (East Africa), with whom are associated Sir Alexander Gibb and Partners, consulting engineers for the civil engineering work. The main contractor for the civil engineering work is the Owen Falls Construction Company, a group of four British and four Dutch firms. Redpath Brown and Co., Ltd., has supplied the structural steelwork for the power-house; Sir William Arrol and Co., Ltd., the 120-ton crane, and Glenfield and Kennedy, Ltd., is responsible for the sluice gates. The Kaplan turbines and alternators are being supplied by Boving and Co., Ltd., and the British Thomson-Houston Company, Ltd., respectively.

EXCAVATION FOR MAIN DAM, OWEN FALLS

Aggregate Plant

In order to supply the large quantities of clean and graded aggregates needed for concrete making in connection with this project, a central crushing, screening and storage plant has been built for the Owen Falls Construction Company by Pegson, Ltd., of Coalville, Leicestershire. Two views of this plant are reproduced on the opposite page.

Up to the time of writing the stone being crushed at Owen Falls is amphibolite, a close-grained igneous rock, and a small amount of river bed gravel. The plant was designed to supply 250,000 tons of coarse aggregate and 125,000 tons of crushed and natural sand in about two years' working. Its capacity for all sizes of coarse aggregate is 125 tons per hour—or up to 96 tons per hour of minus ¾in material when required—and 60 tons of sand per hour. The aggregate sizes required are 3in, 1½in, ¾in, ⅜in and $\frac{1}{16}$in (sand), and additional natural sand, as distinct from the stone sand, is dealt with separately.

Quarried stone is loaded by 1½ cubic yard shovels into 4½ cubic yard dumpers, which tip the material for primary crushing directly into a "Pegson-Telsmith 25 B" gyratory machine. An alternative feed is provided by skips operating on lines adjacent to the crusher. This crusher accepts any stone that can be picked up by the 1½ cubic yard shovels, and with its large capacity of 350 tons per hour has sufficient reserve to deal with fluctuating and intermittent feed, the average feed rate being 125 tons per hour. The crusher is situated above ground level to make possible the inclusion of a minor surge pile of crushed stone inside the foundation walls under the primary stage.

For secondary crushing stone, of minus 8in, is extracted from this minor pile by two "Sherwin" magnetic feeders and transferred to "16 B" primary gyratory crushers. Provision is made in these feeders for extracting any "muck" present in the crushed stone and passing it to ground by chutes.

Each of these "16 B" machines, being of the primary type, can be fed direct from their own large feed storage hoppers if desired. The hoppers are fed by the dumpers and the rock is controlled at the outlet to the crushers by hanging chains. This arrangement permits the "25 B" primary to be stopped when particularly good fragmentation is being obtained by blasting in certain parts of the quarry. One or both the "16 B" crushers can be operated as desired either doing secondary or primary crushing duties. The minus 4½in stone from the "16 B" machines passes by way of chutes to a troughed belt conveyor which is 30in wide, 130ft centres, and handles up to 220 tons per hour of the crushed amphibolite at 200ft per minute. This conveyor and others used in the plant were supplied by Hugh Wood and Co., Ltd.

River bed gravel is fed to this first conveyor as required, from a receiving hopper situated above, and the gravel is extracted from the hopper at a controlled rate by an electric vibrating feeder. Approximately 10 per cent gravel is added to the crushed rock.

Stone and gravel are carried by the inclined conveyor to the screening and surge bin structure. The first and upper screen is a 12ft by 5ft triple-deck inclined vibratory machine. The top or scalping deck rejects all plus 3in stone for recrushing into a rejects chute. The second screen is a 12ft by 5ft double-deck machine. A five-compartment surge hopper receives and stores aggregate from the screens, sizes 3in to 1½in, 1½in to ¾in, ¾in to ⅜in, ⅜in to $\frac{1}{16}$in and minus $\frac{1}{16}$in (sand).

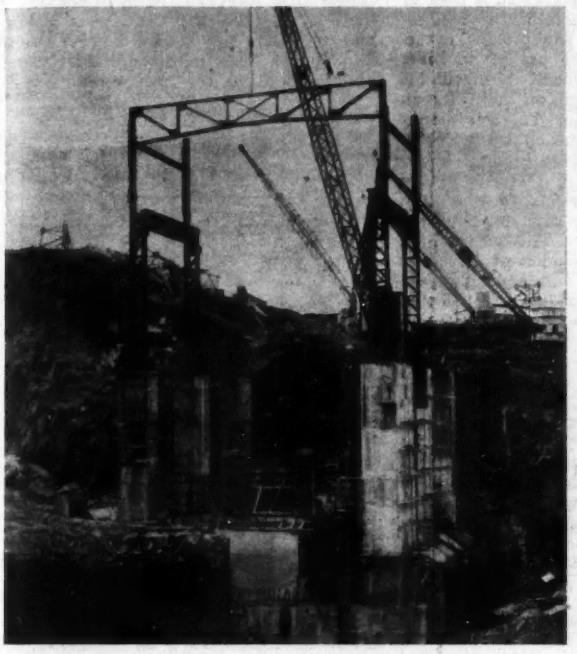
Rejects, plus 3in to 8in material, passes from the first screen to a 20-ton storage hopper by chute and a 20in wide troughed belt conveyor with 30ft centres. Two feeders extract the rejects from the bin and feed by way of chutes into two swing hammer crushers incorporated in the plant to break up the "slabby" rejects preparatory to the final crushing stage. The product from these crushers is transferred by way of a 24in wide, 108ft centres, curved troughed belt conveyor which delivers the stone to the first conveyor and thence to screens, thus completing the closed circuit.

When increased quantities of the aggregate sizes minus ¾in are required, a 48in "Gyrasphere" fine crusher is used. The aggregate sizes 3in to 1½in and 1½in to ¾in are extracted from either or both bins, as required, by magnetic feeders and carried to the fine crusher by an 18in troughed belt conveyor. This machine reduces the stone to minus ¾in size, before it is deposited on to the 24in curved conveyor with the products of the two swing hammer crushers, for rescreening. It reduces the minus 3in stone to minus ¾in at the rate of 45 tons per hour, and serves to boost the quantity of

small size aggregate produced by the previous crushing.

To reduce to a minimum the amount of stone dust in the aggregate, dust collection is arranged at the points where maximum dust is produced. Air is extracted with the dust in suspension, immediately it leaves the crushing zones of the machines, and is dealt with by a 7ft cyclone.

For aggregate handling and storage six major stock piles, each composed of the aggregate gradings specified were laid down. These



POWER STATION STEELWORK

stock piles, which give a total storage capacity of approximately 14,000 tons, including the natural sand, are each about 40ft high. They are formed by five separate inclined troughed belt conveyors, each of which is 18in wide and runs at 150ft per minute, and varying in capacity from 25 to 55 tons per hour according to feed. Each belt takes an individual aggregate size from the appropriate surge bin section of the crushing and screening plant to form the individual stock piles. The delivery end of each conveyor is cantilevered well out from the conveyor supporting tower to leave the base of the stock pile clear of obstruction and ensure easy access for bulldozers or other machines used for removal of stock pile remnants. For reclaiming the aggregate two 26in wide troughed belt conveyors, with 240ft and 195ft centres, are arranged beneath the stock piles in timber tunnels. The aggregate is drawn from any stock pile and deposited on to a reclaiming conveyor by chutes having quadrant valves and swivel size plates. Three outlets are used at each stock pile to ensure maximum aggregate recovery. Each of these two conveyors will handle up to 200 tons per hour. The tunnel conveyors deliver the aggregate on to an inclined troughed belt conveyor which is 26in wide and 258ft long, and discharges into the hoppers of a batching plant at a height of 81ft. This batching plant has a capacity of 200 tons and was supplied by Winget, Ltd.

Predetermined proportions of natural sand for the concrete are dealt with quite separately and independently from the main plant described above. This sand is won from a section of beach on Lake Victoria and is shipped to Jinja by barge, unloaded by grab crane and conveyed to site by lorries. The dry sand is dumped into a water-filled concrete hopper, where a pump extracts a solution (30 per cent sand, 70 per cent water), and elevates it to a sand cone which delivers 40 cubic yards per hour of washed and graded ($\frac{1}{8}$in to 100 mesh) dewatered sand, which is then deposited on to a stock pile situated directly above one of the reclaiming tunnel conveyors. The sand is then batch weighed and fed to the concrete mixers along with the main stone aggregate which has previously been batched to meet concrete specification. The dirty water and silt separated by the sand cone is piped to disposal. This natural sand-washing equipment was supplied by William Mosley (Engineers), Ltd.

All crushers, screens and conveyors are independently driven by totally enclosed, surface-cooled motors having "tropical" windings. The motor control equipment is concentrated at two points. For the primary, secondary and tertiary crushing stages the controls are stationed in an elevated housing commanding a complete view of the plant. The second switchgear point is situated at the top of the main screening section and controls the screens and conveyors. Sequence starting is arranged for and emergency push-button "stop" switches are arranged at all essential points.

To deal with the heavy lifts when erecting and for subsequent servicing of the plant a 10-ton, 120ft derrick was installed to cover the large primary and secondary crushers. All the main bearings of the crushers are lubricated automatically to make the machines independent of the attention of unskilled native labour.

Argentine Grain Elevator

SIMON HANDLING ENGINEERS, Ltd., Cheadle Heath, Stockport, has recently completed the fitting of the mechanical and electrical equipment of the largest grain elevator in South America. The Buenos Aires elevator is the fifth to be completed since 1938, the other elevators being at Rosaria Sud (75,000 tons), Villa Constitucion (54,000 tons), Quequen (48,000 tons), and the extension to 140,000 tons of the 80,000-ton elevator at Ingeniero White. The Buenos Aires elevator, which has a storage capacity of 150,000 tons, is capable of receiving, storing and shipping 1,500,000 tons of grain per annum.

Grain is delivered by road, rail and water. The rail wagons are unloaded by four intake lines of conveyors, each having a capacity of 500 tons per hour, power shovels being provided for bulk wagon discharge. Road vehicles discharge to a similar intake line with a capacity of 250 tons per hour, and for handling water-borne grain there are two travelling pneumatic plants on the dock side, each of 70 tons per hour capacity.

In addition to the handling machinery there is a grain cleaning and drying plant and a dust collecting installation. The grain is moved by some sixty-five conveyors, which have a total length of 5 miles and twenty elevators, some of which measure 260ft between head and boot pulley centres. For operating the various motors a total of 7500 h.p. is required. The cleaning plant, which can deal with 3700 tons of grain per day, consists of warehouse separators, oat clippers and disc separators and there are a number of cleaning machines for re-treating the screenings of the main cleaning plant. The drying system incorporates three grain dryers with a daily capacity of 440 tons. Fourteen separate plants form the comprehensive dust-collecting system and the dust, after being discharged into collecting chambers, is sprayed with water and then pumped into the sea in the form of sludge.

A pneumatic tube signalling system has been installed for transmitting messages from point to point in the [large building and] an elaborate electric control and signalling system enables each individual wagon load of grain to be traced through the elevator and identified at any stage of its journey. The operation of the whole elevator is controlled from a main signalling and control panel.

ARRANGEMENT OF CONVEYORS AND SCREENING AND STOCKING-OUT SECTION

Metallurgical Topics

Arc-Cast Molybdenum

ALTHOUGH metallic molybdenum was first isolated in 1782 by the Danish chemist, P. J. Hjalm, a century and a quarter elapsed before it was successfully produced in a coherent and ductile form. In 1910 Colin Fink reported the properties of molybdenum in the form of wires made by the methods of powder metallurgy previously applied to the manufacture of tungsten filaments. The applications of metallic molybdenum were limited to its use for small components of lamps, vacuum tubes, &c., in which a vacuum or an inert gas protected it from oxidation. Molybdenum powder is made

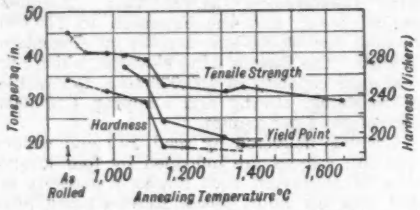


FIG. 1—*Tensile Strength, Yield Point and Hardness of ½in Diameter Hot-Rolled Bar of Arc-Cast Molybdenum, Annealed at Different Temperatures.*

by the reduction of molybdenum trioxide, obtained from ammonium molybdate, by hydrogen. Up to 1940 the powder-metal compacts as ordinarily produced did not exceed a few pounds in weight. In subsequent years there was an increasing demand for materials resistant to very high temperatures and an intensification of research on metals of high melting point. Molybdenum was relatively abundant and was notable for its high melting point of 2622±10 deg. Cent. The powder-metallurgy method was so modified and improved that masses of molybdenum weighing up to 500 lb were made available. The further mechanical treatment of these metallic compacts by rolling and other forms of hot or cold working presented no unusual difficulties. It was early realised that applications of the pure metal would be limited by its strength; and alloys, also produced by powder-metallurgy methods, were investigated. Hitherto all attempts to make solid ingots of ductile molybdenum by melting and casting

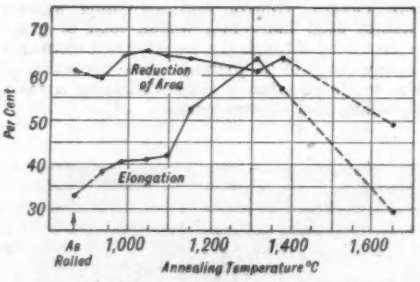


FIG. 2—*Elongation and Reduction of Area of ½in Diameter Hot-Rolled Bar of Arc-Cast Molybdenum, Annealed at Different Temperatures.*

had failed, not (in recent years) because of its high melting point, but mainly because of contamination from the atmosphere or from the crucible. By 1946, however, the Climax Molybdenum Company had devised a successful means of melting and casting the metal. The paper describing the process was published jointly by R. M. Parke and J. L. Ham[1], and these two investigators have recently been responsible for two separate accounts[2,3] of advances in the metallurgy of molybdenum, which together give a most valuable and comprehensive statement of the present position. A great impetus has been given to production by the recently developed arc-cast process. Ingots up to 6in in diameter and 150 lb in weight are now being produced and equipment for the production of 1000 lb ingots, 9in in diameter, is under construction.

THE ARC-CAST PROCESS

Melting takes place in an alternating-current arc, which operates between a vertical, consumable molybdenum electrode and a pool of liquid metal. Contamination of the melt is avoided by carrying out the process in an evacuated space, or by the use of an inert gas. The consumable metal electrode is formed continuously by extruding molybdenum powder through a special die. This electrode is continuously being strengthened by a sintering action due to the heating brought about by resistance to the current it carries to the arc. The lower end of the electrode, where the arc is formed, becomes hot and drips molybdenum into the pool below. This pool is held in a water-cooled hollow cylinder, which serves both as melting chamber and casting mould as it becomes filled. Deoxidation is effected by adding a small amount of carbon and pumping it off again as carbon monoxide. Unless the oxygen content of the cast molybdenum is reduced to below 0·003 per cent, precipitation of oxide may occur in the grain boundaries and the material becomes practically unforgeable. Alloys which can be obtained by melting in a vacuum are limited to those of elements which do not give excessive volatilisation at the temperature involved. Some elements which would otherwise show undue volatilisation can be added if melting

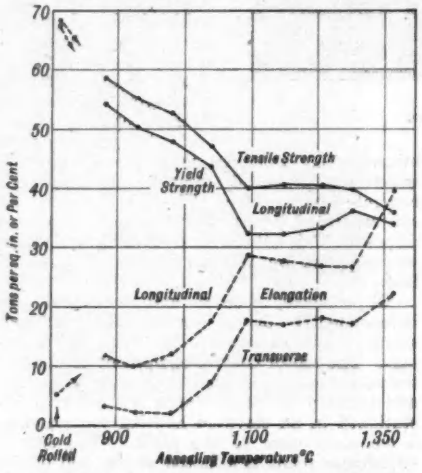
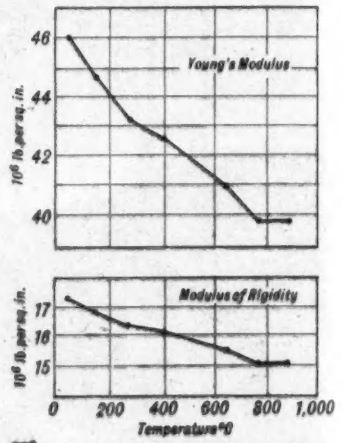


FIG. 3—*Tensile Strength, Yield Strength and Elongation of Cold Rolled Arc-Cast Molybdenum Sheet, Cold Rolled from 0·052in to 0·020in and Annealed at Different Temperatures.*

is carried out in an inert gas, but then there is no way of removing the carbon monoxide, so that a purer material has to be used at the start. The advent of the arc-cast process has greatly simplified the production of high-purity, ductile molybdenum and its alloys in sizes which permit extensive testing; and this has justified a review of the knowledge of their properties, gained from the examination of powder metallurgy products.

MECHANICAL PROPERTIES OF ARC-CAST MOLYBDENUM

The Climax Molybdenum Company has issued information about the tensile properties of arc-cast molybdenum in the form of hot-rolled rods, ½in in diameter, hot-rolled and annealed sheet down to 0·013in thick, sheet cold rolled from 0·052in to 0·020in thick, as well as certain tensile and creep-rupture tests at high temperatures. The tensile properties of hot rolled and annealed arc-cast molybdenum are shown in Figs. 1 and 2; those of cold rolled and annealed sheet in Fig. 3. Tensile strength is about the same in longitudinal and transverse directions but the elongation is much lower in the transverse tests. In short-time tests the tensile strength of hot-rolled arc-cast molybdenum fell to about 27 tons per square inch at 870 deg. Cent. and then progressively to 17 tons per square inch at 1070 deg. Cent. The corresponding values after recrystallisation of the cold-rolled material at 1225 deg. Cent. were about 15·5 and 9·5 tons per square inch, respectively, and on the basis of rupture after 250 hours about 9 and 2¼ tons per square inch. The



Poisson's Ratio varied from 0·314 to 0·330, average 0·321.

FIG. 4—*Effect of Temperature on the Elastic Moduli of Hot-Rolled Arc-Cast Molybdenum.*

effect of temperature on Young's modulus and on the modulus of rigidity is shown in Fig. 4.

MOLYBDENUM-RICH ALLOYS

It is clear that, in accordance with usual experience, the pure metal can find only a very limited use and interest therefore centres on alloys of molybdenum. The primary purpose in the use of alloys is to improve the strength both at ordinary and at high temperatures. Selection of alloys for investigation was made on scientific grounds involving consideration of the crystal structure of the component metals. Alloys with elements which form

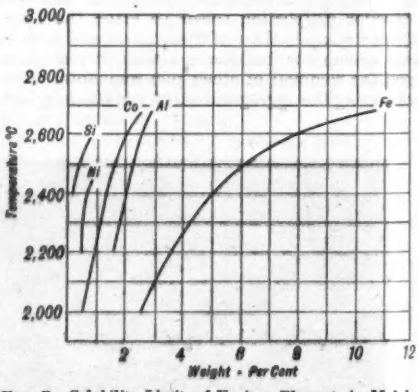


FIG. 5—*Solubility Limits of Various Elements in Molybdenum.*

hard, brittle, insoluble compounds are not of any practical interest. Experience has also shown that the introduction of a large amount of a second phase may increase the hot hardness to such an extent that the alloy ceases to be forgeable. Until forging technique is further advanced, alloys containing a second phase in massive form may be excluded from consideration. Apart from the use of these methods increased hardness may be obtained by the formation of a solid solution, a supersaturated

solid solution carrying with it the possibility of precipitation hardening, or a work-hardened solid solution. Of these, the first is constitutionally stable, whilst properties induced by the other conditions will be transient at a sufficiently high temperature.

Ham[3] has reported on an extensive investigation of molybdenum alloys which were prepared by melting in the arc, either in a vacuum or in argon at one atmosphere pressure. Binary alloys of molybdenum with V, Ti, Cr, Mn, Fe, Co, Ni, Zr, Nb, Ta and W were prepared, and also with three other elements, Be, Al and Si, which were thought possibly to be effective as deoxidising agents, but of which little else was expected. The solubility limits of Si, Ni, Co, Al and Fe (Fig. 5) were determined by X-ray measurements of lattice parameters. The hardness of the cast alloys at room temperature and at 870 deg. Cent. is shown in Figs. 6 and 7. These data served to guide the selection of alloys for more detailed study. So far it has been found possible to forge only those alloys whose hardness at 870 deg. Cent.

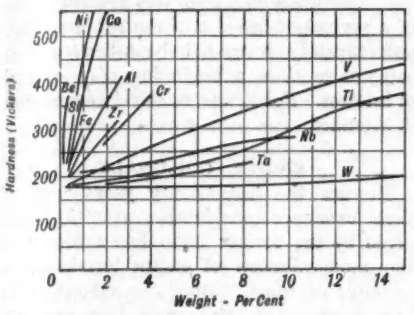


FIG. 6—*Hardness at Room Temperature of Molybdenum Alloys, as Cast.*

did not exceed 90, though, if suitable dies were available it might be possible by extrusion to make useful products from alloys with an initial hardness of 180 at that temperature.

Beryllium turned out to be a metal having a powerful effect, in that it conferred a susceptibility to heat treatment when present in the alloy to the extent of only about 0·05 per cent. Fig. 8 shows the hardness at room temperature of two alloys after being quenched from high temperatures. According to H. J. Goldschmidt, who is quoted, certain iron-chromium-molybdenum alloys containing from 60 to 92 per cent of molybdenum appear to be promising as heat resisting materials.

Applications

Possible applications, opened up by the greater availability of molybdenum, and now under investigation, include piercing plugs for seamless steel tubing, gas turbine blades,

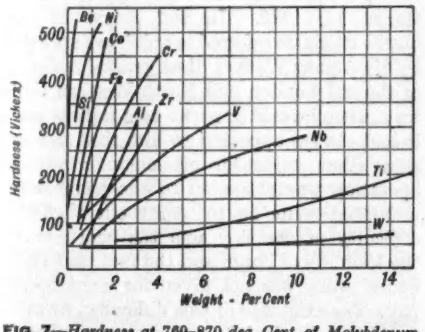
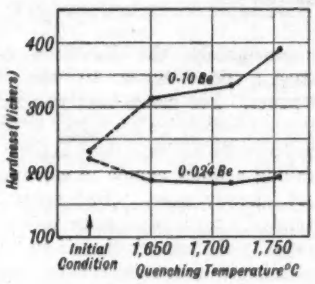


FIG. 7—*Hardness at 760–870 deg. Cent. of Molybdenum Alloys, Cast and Annealed at 1320 Deg. Cent. (except Ti Alloys, Annealed at 1925 Deg. Cent., and Alloys with Be, Nb and W, not annealed).*

electrodes for heating molten glass, die-casting dies for brass and other non-ferrous materials of high melting point, components of turbo-jet engines, rockets and nuclear reactors, and parts exposed to certain corrosive chemicals.

However, a point has not yet been reached at which specific compositions can be selected for particular applications. Because of weight considerations, most aircraft-engine applications of molybdenum will require fabrication of sheet into the finished parts by forming and welding. For this purpose elements which raise the recrystallising temperature of molybdenum must be employed. The minimum recrystallising temperature of arc-cast molybdenum varies from 970 to 1070 deg. Cent., according to the amount of cold work that it has undergone and to other conditions. Carbon reduces the recrystallisation temperature, but the titanium alloys (which form a continuous series of solid solutions from pure molybdenum to pure titanium[4]) are superior to others in this respect, requiring a high temperature for recrystallisation.

A high rate of oxidation at high temperatures is one of the major disadvantages of molybdenum and presents the most important and the most difficult problem to be solved before the metal can be widely used in heat engines. The oxide, MoO_3, forms and vaporises at a considerable rate at temperatures above 750 deg. Cent. Alloying with chromium—



Initial condition: 0·10 Be, as slowly cooled; 0·024 Be, as forged.

FIG. 8—*Effect of Quenching on the Hardness of Molybdenum-Beryllium Alloys.*

so effective in reducing the rate of oxidation of iron at high temperatures—is of little value in arresting the formation of the volatile oxide of molybdenum. Methods of protection which are being developed include coating with another metal more resistant to oxidation, either by "cladding" or by electrodeposition; formation of a surface layer of molybdenum disilicide by heating the metal in an atmosphere of hydrogen and silicon tetrachloride; or the use of a ceramic coating. So far, no molybdenum-rich alloy has been found to possess high resistance to oxidation or a surface having a capacity for self healing in the event of damage. It is evident, however, that in spite of the disadvantages and difficulties which have still to be overcome, good progress has been made in the production of molybdenum and its alloys and in the initial development of products which are probably destined to play an important part as heat-resisting materials.

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[1] R. M. Parke and J. L. Ham: "The Melting of Molybdenum in the Vacuum Arc," *Metals Technology*, September, 1946.
[2] R. M. Parke: "Molybdenum, a New High-Temperature Metal," *Metal Progress*, July, 1951, vol. 60, page 81.
[3] J. L. Ham: "An Introduction to Arc-Cast Molybdenum and its Alloys," *Trans. Am. Soc. Mech. Engrs.*, August, 1951, vol. 73, page 273.
[4] M. Hansen *et. al.*, *Journal of Metals*, October, 1951, page 881.

Improvement in Hot-Working of Stainless Steels

The hot working qualities of any particular grade of stainless steel determine to a large extent its availability as bars, sheet, strip, plates and other commercial wrought products. The rare earth elements have been found to be effective in improving the hot working qualities of highly alloyed austenitic or partially austenitic grades of stainless steels and heat-resisting alloys containing up to 70 per cent of nickel with 10 to 60 per cent of elements from the group of chromium, molybdenum and tungsten, the amount of any one of these three not to exceed 30 per cent. In many instances, heat-resisting alloys falling within these limits of composition are available only as castings and are not considered suitable for hot working. Some of them, however, may be converted into wrought products when their composition is modified by the addition of a small amount of "mischmetall." In others, the effect is to improve hot working qualities, giving better ingot-to-billet yields, requiring less billet preparation and showing superior surface finish in the hot rolled strip. Examples of the beneficial effects of the rare earth elements are given by members of the metallurgical staff of the Carpenter Steel Company, Reading, Pennsylvania, in a paper* on "Hot Workability of Stainless Steel Improved by Adding Cerium and Lanthanum." The term "rare earth elements" refers principally to cerium, lanthanum and those other metals commonly associated together in "mischmetall."

The range of cerium and lanthanum needed to obtain improvement in hot working is determined mainly by the nickel content of the alloy, but is also influenced by such alloying additions as molybdenum, tungsten and copper. Tests were made on low-carbon (0·05 per cent) alloys containing about 10 per cent chromium with:

Nickel, per cent...	10	30	50	60	67
Molybdenum, per cent ...	7·7	8·0	4·2	16	19

and also on various complex steels with chromium up to 25 per cent. Alloy additions of cerium and lanthanum in the range 0·02 to 0·04 per cent were found to be effective in promoting better hot workability in high-frequency and basic electric arc melts of alloys of the types:

Type No.	C (max.)	Cr	Ni	
308 ...	0·08	19/22	10/12	Mn 2 (max.)
310 ...	0·25	24/26	19/21	—
316 ...	0·10	16/18	14 (max.)	Mo 2–3

Alloy additions of cerium and lanthanum in the range 0·08 to 0·18 per cent were found to be effective in achieving hot workability in nickel-chromium-molybdenum-copper, nickel-chromium-tungsten and other highly alloyed steels, useful for their resistance to attack by sulphuric acid or for their strength at high temperatures. No information is given as to the influence of these additions on the other properties.

Nickel-Iron Alloys

Nickel and iron form a series of alloys which are outstanding for the wide range of physical properties that they exhibit. The Mond Nickel Company† has collected together, in an attractively produced booklet of twenty-two pages, information about the properties (other than magnetic properties which are dealt with in a separate publication) of alloys containing, for the most part, upwards of 25 per cent of nickel. The work of Guillaume and of Chevenard on these alloys first directed attention to their dilatational and elastic properties, the whole field of which, with its constitutional background, is summarised in the publication. Its value to the practical engineer and instrument designer is enhanced by the manner in which it deals also with the applications of these remarkable alloys in metrology and geodetic surveying, in temperature measuring and thermostatic devices, in glass-to-metal seals, and in ingenious packing sleeves to minimise temperature stresses, where control of thermal expansion is the essential requirement; and with their use as hair springs, springs for balances and pressure gauge diaphragms which depend on a constant modulus of elasticity for their accuracy under fluctuations of temperature.

* C. B. Post, D. G. Schoffstall and H. O. Beaver, *Journal of Metals*, November, 1951, page 973.

† *The Physical Properties of the Nickel-Iron Alloys*, published by The Mond Nickel Company, Ltd., Sunderland House, Curzon Street, London, W.1.

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NOISE

THROUGHOUT the centuries the quiet of this earth has been afflicted by man-made noise, especially in cities. Long before the modern engineer came upon the scene and introduced those prime makers of noise, metallic machines, carts rumbled over cobbles, the iron-shod hooves of horses clattered on roads and the cries of street hawkers rose above the babel of thousands talking and bargaining in markets. Yet was there ever an age quite as continuously noisy as our own? Is it not true that man is becoming noisier and noisier? Has he not even produced lately by the explosion of atom bombs noises louder than he ever produced before, noises to beat all previous noises? We have to confess, too, that it is the engineer, in particular, who is the creator of noise. And, were we asked to single out one particular class of his machines not necessarily as the noisiest in itself, but, through its multiplication, as the creator of more noise than any other, would we not have to choose the internal combustion engine? That engine has, indeed, brought untold benefits to mankind. It is, in fact, impossible to conceive how modern civilisations could continue to exist bereft of that engine, whose sound dominates the streets of cities and whose roar, in the tractor, now even disturbs the quiet of the countryside. Of course, the internal combustion engine is not the sole offender. There are others, less prolific, but even worse, such as pneumatic road breakers and their compressor plant, steel wheels running over steel rails, as in trams and trains, riveting machines and hosts of others. But, taking it all in all, could engineers but quieten the internal combustion engine the world would be a greatly more comfortable place in which to live.

It is, of course, mechanical engineers who are primarily to blame. For it is their products rather than those of civil or electrical engineers that are the creators of noise. We were therefore glad to attend a meeting of the Institution of Mechanical Engineers three weeks ago, when the subject of noise came up for discussion. In last week's issue we printed an abstract of the paper by Mr. C. H. Bradbury, which the members discussed. But, unfortunately, the discussion, in our estimation, added little to the value of the paper. For much that was stressed was common knowledge long ago. It was, for instance, pointed out that there is little point in installing a quiet engine in surroundings that are already noisy. But many years ago somebody made the same point more amusingly by the remark that if two babies are screaming in a room it leads to very little improvement to remove only one of them! Again, it has long been appreciated how difficult it is to measure noise satisfactorily. A co-ordination can be found, it is true, between the energy of a sound and the loudness apparent at a human ear. But the ear is sensitive not only to loudness, but also to so ill-defined a quality as offensiveness, a quality associated in some way, not with the energy, but with the pitch of the sound and probably with the particular combination of pitches concerned. But if upon the more scientific plane the discussion was not very illuminating, there was more of interest to be found upon the practical side. The basic object of the paper was to show by what means the noises created by oil engines could be traced to their sources and there quietened. To some extent, of course, that has long been done. Indeed, listening to the discussion, we were driven to doubt a little whether all the instruments that are being devised for doing it are really such great improvements upon the doctor's stethoscope that was so much used before the war! The hope is held out that eventually so much will be learned about the sources of noise by the new instrumental methods that it may prove possible to design an engine to be quiet in the first place. Yet the hope may prove vain. For there are so many surfaces and shapes on a machine that can act as sounding boards, picking up and multiplying the energy of noises created elsewhere, that we cannot but doubt whether it will ever be possible to predict at the design stage how quiet a machine will in fact prove to be.

Before the war a great amount of work was being done on the reduction of noise. Engineers, as a whole, seemed interested in the subject and quite a high proportion of research effort was being put into it. Efforts were being made—to mention very few amongst many—to quieten trains and particularly tube trains; to seal off passengers from the noise of the engines of road coaches, cars, aircraft, &c.; and to reduce the noise of turbine gears and ships' fans. Even the possibility of silencing concrete breakers was being studied. But since the war much of the interest seems to have evaporated. During the war, of course, engineers had matters of more immediate importance to think about, so that much research on noise was given up; and since the war, no doubt, there has been so great a need to press up productivity that managements have not looked with favour upon researches likely to delay rather than to encourage production and unlikely to influence the profitability of sales. It was, indeed, obvious that several of those who spoke in the discussion at the "Mechanicals" had had little contact with the subject since pre-war days. We hope that this meeting at the "Mechanicals" indicates the beginning of a revival of interest in the subject. But unfortunately it cannot be taken to indicate more than a beginning of a revival of interest. For it was, relatively, somewhat ill-attended.

ENGINE TERMINALS

DURING the last twenty years or so of their existence considerable attention was given by the former main line railways to the modernisation of engine terminals, an example of which formed the subject of an important paper read early this year by R. F. Harvey, Chief Officer Motive Power, Railway Executive. This paper, read before the Institution of Locomotive Engineers in February, dealt particularly with the rearrangement of the Motive Power Depot at Polmadie, Glasgow, recently completed.

Polmadie is one of the more important locomotive terminals, providing, as it does, power for Anglo-Scottish express passenger workings as well as main line freight and local train services. The value of what may be termed up-to-date facilities for the proper preparation of motive power is in itself just as worthy of attention as the design and construction of the locomotives themselves, one being, in fact, the counterpart of the other. Almost thirty years ago we called attention to the inadequacy of engine sheds for the work required, our remarks on the subject, under the title of "The Locomotive Hour," appearing in our impression of March 24, 1922. In the course of our observations we referred to opinions expressed by Sir Arthur Watson, then general manager of the old London and North-Western Railway, when he said in part: as a railway man it had always appeared to him that the one thing that made for efficiency in railway operation was attention to the locomotive, and then went on to point out that the difficulty of the day was the shortness of the locomotive hours and the fact that eight hours' work was not given for eight hours' pay. The existence of this difficulty, we said, could not be denied, and suggested that it could "best be surmounted by allocating to a given service engines fitted for that service and seeing to it that they were loaded to their economic capacity and that terminal facilities are such that the work necessary to prepare and repair engines may be carried out efficiently and with the least delay so

that the time they are available for the needs of the traffic department may be as great as possible." During the intervening years, as we have already stated, a good measure of practical consideration has been given to the arrangement and equipment of engine terminals, while more recently the economic loading of engines has been the subject of investigation.

So far as running shed modernisation is concerned, the scheme inaugurated by Sir Ernest Lemon on the London, Midland and Scottish Railway about 1932 constituted one of the greatest advances made in this direction. The entire project was estimated to cost £1,115,500, of which £750,000 had been authorised between 1933 and 1937 for improvement to some forty-seven different depots. In certain instances the remodelling carried out is stated to have resulted in savings in the time occupied in replenishing coal and water supplies, disposing of ashes and turning of engines by as much as 60 to 70 per cent. The rearrangement of the large engine depot at Polmadie, which has brought it well to the forefront in equipment provided and in its general lay-out, is a creditable accomplishment. It may be said to be a continuation of Sir Ernest Lemon's policy first put into practice almost twenty years ago. When discussing the paper to which we have referred, R. C. Bond emphasised the value of properly equipped and planned engine depots, pointing out: "Where the diesel locomotive has supplanted steam power, it has been regarded as essential that the most modern form of running shed should be provided as a matter of course," and went on to say that "it is at least arguable that more generous expenditure on the servicing facilities for steam locomotives would have modified appreciably the steam versus diesel balance sheet." Whatever form of motive power is employed, detentions for maintenance and inspection are inevitable, and the more expeditiously these can be carried out, the greater can be its revenue-earning capacity.

Literature

Advances in Applied Mechanics. Vol. II. Edited by R. VON MISES and T. VON KARMAN. New York: Academic Press, Inc. 1951. Price 6·50 dollars.

ACCORDING to the preface, the express purpose of this series of volumes (of which this is the second) "is to give surveys of the present state of research work in various fields of applied mechanics." The editors have deliberately given a large measure of freedom to the authors of the various papers who have not been expected to provide a series of abstracts of papers previously published, nor to supply in every case a complete set of references to papers elsewhere accessible. The papers are written by authors who are actively engaged in the particular field of research, and who are free to develop their own views. All these are laudable intentions, but such freedom calls for a certain discipline on the part of the authors in presenting a reasonably unbiased account of previous work in so far as it leads up to their own developments, and it is a little surprising to find in some cases that previous work which has constituted a distinct contribution to a subject is completely ignored, both in the text and bibliography.

The title of applied mechanics embraces nowadays an immense range of mechanical phenomena. In America it appears, however, to be narrowing its field in its approach to the phenomena, if these—and other recent papers—are any indication: none of the papers quotes the results of experimental investigation, although the definition of applied mechanics would suppose that theoretical work would be supported by experimental evidence. The papers are exclusively theoretical. Not only are no new experimental results reported, but there is no comparison of, or comment on, the theoretical results with respect to existing experimental results in those cases where such exist.

The papers cover a wide range of specialised topics and owing to the editors' policy of allowing each author to give his own views and solutions, the papers require the critical comment of a specialist in each field. A reviewer can therefore only properly comment on the papers with the subject matter of which he can claim some intimate knowledge. The present reviewer may perhaps be allowed to comment on the paper on "Bending of Curved Tubes," by R. A. Clark and E. Reissner, in this way. This paper, a work of some thirty pages, sets out to produce a mathematically exact set of differential equations, which, it is claimed, can be applied to a wide range of problems, such as the bending of curved tubes of various cross sections.

The practical problem underlying this investigation is the calculation of the flexibility of pipe-lines in which bends and curves occur. It has been known for many years that a curved tube is much more flexible in bending than a straight tube of the same cross section, and several theories have been put forward from time to time since Bantlin's experiments of 1910.

The solution offered in this paper for bending of a pipe with circular cross section (the bending moment acting in the plane of the bend) is not, however, the solution of the exact equations, but of a simplified set of equations which are obtained from the exact ones by making various approximations. The approximations are such that the problem is solved within broadly the limits set by von Kármán in his original analysis of 1911; thus, the bore of the tube is assumed to be small compared with the radius of curvature of the bend, the hoop direct stress is neglected and the length of the middle surface of the cross section is assumed to remain unchanged. The recent paper by Pardue and Vigness presents the solution in outline for the case where the first of these assumptions is not made and in the discussion on this paper experimental results are presented which clearly show that the effect of the hoop direct stress is not negligible. The authors of the present paper present two separate solutions to cover the range of pipe factors normally met with in practice, although almost the complete range is already covered by Beskin's solution put forward in 1945.

The use of this solution for tubes of non-circular cross section may, however, be more attractive, but it is not possible to assess the value of the work in this respect because no comparison is made with experimental measurements of the stress distributions existing in such a bend. Barthélemy and his collaborators in France have also considered this problem, in which the wall thickness of the tube is additionally considered as a variable.

The other papers in this book include one on the statistical theory of isotropic turbulence, by von Kármán and Lin, one on the laminary boundary layer in compressible flow by Kuerti, and one on the theory of filtration of liquids in porous media by Polubarinova-Kochina and Falkovich. Nemenyi contributes a paper on "Recent Developments in Inverse and Semi-Inverse Methods in the Mechanics of Continua." By an inverse investigation is meant one in which the boundary conditions are not prescribed at the outset in investigating a partial differential equation of any physical problem, the solution being defined by the differential equation and certain other properties of the continua. In the semi-inverse method some of the boundary conditions are defined. The idea is discussed in relation to various branches of applied mechanics. There is a section on plane strain problems in plasticity, but the method has not yet been developed to the point where it can be applied to particular problems.

Applied Mechanics for Engineers. By Sir CHARLES INGLIS. London: Cambridge University Press, 200, Euston Road, N.W.1. Price 42s.

THIS book is based on the second and third-year courses for the Mechanical Science Tripos at Cambridge, and assumes first-year knowledge of mathematics and mechanics; all the additional mathematical tools required are given in it as the need arises. In particular, approximate methods are introduced almost from the beginning; the student is early brought up against the limitations in precision of engineering data and made to realise the value of graphical and numerical methods of solution. This should help to dissipate the common fallacy that so-called exact solutions have an almost mystical value, although they may require such drastic simplifying assumptions that the exactness is in reality no greater than can be much more easily obtained by approximate methods.

Within the chosen field, the author has ranged widely and covered many interesting problems. In order to limit himself to some extent he has completely excluded fluid mechanics, and but touched upon problems of mechanism. Problems of taut and slack wires and suspension applications are much more fully dealt with than usual and provide a very useful field for illustrating the power of methods of solution here given. Frameworks are also dealt with at some length, whilst in the field of dynamics vibrations receive considerable attention, including practical cases of coupled and non-linear vibrations. The gyroscope is also fairly fully dealt with. The fundamentals of statics and dynamics are covered with particular reference to the applications already given and, in addition, there are chapters on dry friction, harmonic motion and analysis, circular and curved motion, moments of inertia, energy and momentum.

The book is written throughout in a clear and refreshing style, with examples in both the text and as problems which are interesting in themselves. Some of the problems which are chosen for the principles they demonstrate require considerable time to solve, and whilst this makes them much more realistic, and a better introduction to real design problems, it would have been an advantage to the student preparing for an examination if there was some indication as to which problems are of this nature and which are taken from examination papers.

Sir Charles Inglis has made very clear certain aspects of the subject which are a frequent source of confusion in students' minds. In particular, attention may be drawn to the lucid exposition of the difference between conservation of momentum and conservation of energy; to the determination

of the components of acceleration in rotating bodies and the reasons for the Coriolis' component (which, for some reason, is never called by that name); the treatment of the deformation of frameworks, and the introduction to non-linear problems.

In the slug controversy, Sir Charles is a poundal man; whether the student will keep clear of trouble with "g" would probably depend on his previous familiarity with the poundal system.

One of the few blemishes in the work is the inclusion of worm drives under problems of dry friction, with the conclusion that to be reversible "the worm must have a steep pitch, hardly less than 45 deg.," with a reference to an early worm drive car. This is likely to mislead a student, since apart from the confusion between pitch and lead angle, heavy commercial vehicles quite commonly have worm gears of about 25 deg. lead angle which are certainly reversible, whilst nearly all industrial worm gears are used lubricated and are consequently reversible at quite low lead angles.

The absence of an index in a work of this importance and at such a relatively high price is deplorable and detracts considerably from its usefulness. It is the more regrettable, since the methods used and the points made are of value to the practising engineer in industry as well as to the student.

Some Aspects of Fluid Flow, Being Papers Presented at a Conference Called by the Insitute of Physics. London: Edward Arnold and Co., 41, Maddox Street, W.1. £1 10s.

THIS conference in October, 1950, at Leamington discussed fifteen papers on flow of various fluids, written by physicists and engineers in research laboratories of many industries, with the object of comparing the difficulties arising as a result of applying the fundamental physics of fluids to large-scale processes, mainly chemical engineering.

There are few original accounts of quantitative experiments, the remainder being surveys of past work, reworking of previously published data, and qualitative accounts of experimental techniques. This is not to decry the importance of the latter parts, as the bibliographies alone will prove valuable starting points for many workers in the future.

Meetings such as these are one way of removing the reproach that industrial application lags too far behind fundamental research; and it is regrettable, as Mr. R. L. Brown says in the report of the discussion on the combined flow of fluids and solids, that but for the discovery of the electron we should be much further forward to-day in having adequate design data; to-day's questions of classical physics have not the glamour of the atom, but a physicist of 1850 would have found them intensely interesting.

The discussions reported at the end of the book brought out many ideas, and Mr. M. W. Thring's concluding statement and summary analyse the interdependence of theoretical and research physics with the industrial development and practice of full-scale processes. The book has been edited by Dr. Lang, Secretary of the Institute of Physics.

The First Hundred Road Motors. By R. W. KIDNER. Godstone, Surrey: Oakwood Press. Price 9s. net.

THE various previous books from this publisher have brought before us well-documented historical and descriptive essays on mechanical transport by road and rail, written by a number of enthusiasts in those subjects. One of those enthusiasts, and the most prolific, is Mr. Kidner. In this, the latest of his many brochures, he has gathered an amazing amount of information, not only about the motors themselves, but about their designers and constructors. Some of this information has not previously been recorded. It is always a difficult task to decide what to include in the first hundred motors, and here his criterion has been, very properly, those motors that were actually built and operated; he has not omitted to mention, however, possibly fifty others, such as traction engines, self-propelled fire engines and road steamers. The period covered is 1769–1871. What is amazing, though it is not emphasised as much as it might have been by the author, is the large proportion of the motors that are of British vintage, for in this, as in the case of rail locomotives, Great Britain led the world. A valuable feature of the brochure is the number of illustrations that the author has managed to squeeze in. There are an average of three on each of twenty plates, besides line drawings in the text. The author does not seem to have missed anything that got on to road wheels during the whole of the period in question. There is, indeed, a notable absence of mistakes of any kind. But we must point out one, which occurs on page 9. Joseph Bramah died in 1814; it was his son who was in control in 1821. Sir Frederick Bramwell's name is also incorrectly given as Bramall in at least five places. On page 34 Savage is written for Savaage. But these are minor defects in otherwise an excellent production.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

1000kW ALLEN GAS TURBINE

SIR,—We are grateful to our old friend, Mr. R. C. McLeod, for the tribute paid by him to Power Jets, Ltd.

Your comment, Sir, regarding the present tendency to take their work "as read" is only too true, and we have great pleasure in acknowledging that the design of the Allen gas turbine has been considerably influenced by the pioneering work of Power Jets, Ltd.

H. NORMAN G. ALLEN,
Engineering Director,
W. H. Allen, Sons and Co., Ltd., Bedford
December 14th.

An Analysis of Ship Vibration Using Basic Functions

MR. J. E. RICHARDS read his paper, "An Analysis of Ship Vibration Using Basic Functions," before the North-East Coast Institution of Engineers and Shipbuilders on November 23rd, and a summary is given below.

The paper describes an analysis of ship vibrations using basic functions and the object of the work was to investigate whether the results of exciter tests carried out by B.S.R.A. could be used to obtain information as to the engine unbalance which can be permitted without causing unpleasant vibration. It is stated that the hull of a ship is a complex structure and its modes of lateral vibration cannot be represented by a simple mathematical equation. Further complications are introduced by the entrained water effect, and to render the problem amenable to simple mathematical methods it must be idealised.

The calculation of the natural frequencies of the higher modes of vibration is difficult and the "energy" methods proposed as extensions to the Rayleigh method are approximate and limitations of the Stodola method, it is stated, prevent the full integral method being applied to the higher modes of vibration. In the paper it is mentioned that the method given by Sir Charles Inglis appeared ideal, and it was found possible to extend this method to take into account shear deflection. The analysis is applied to the vertical vibration of the "Ocean Vulcan," and comparison is made between calculated and measured frequencies and profiles of vertical vibration for five conditions of loading.

In order to assess the importance of various vibration factors the author states that the hull girder is assumed equivalent to a uniform beam and the analysis of the natural vibration without damping is modified to account for certain factors, which are listed. The theory of the lateral vibration of "free free" beams is set out and the "Ocean Vulcan" is considered as an equivalent prismatic bar and various effects are examined such as the variation of loading along the length of the ship, the non-uniformity of sectional moment of inertia, shear deflection and rotatory inertia, and the effect of flotation in water.

A section of the paper discusses the effects of damping and the forced vibration of the "Ocean Vulcan" is considered. In the discussion of the results it is mentioned that, regarding the human reaction to vibration, a sinusoidal vibration with a maximum acceleration of 0·3ft per second per second for a frequency range 0 to 400 cycles per minute represents the beginning of unpleasantness. Vibration frequencies are discussed and the value of J, under certain conditions, is given for two, three and four-node modes and commented upon. Among the other statements made are that the simple theory of bending holds good and that the mean angle of shear of the structure is proportional to the total shear force across the section.

More Diesel Locomotives for British Railways

A RECENT announcement by the Railway Executive states that during the five years 1953–1957 it is proposed to add 573 diesel shunting engines to the locomotives in service. At present there are some 130 diesel-engined shunting locomotives at work on British Railways, and a further eighty-four which have been authorised are additional to those planned. This decision to increase the number of diesel shunting engines in service is the result of a special investigation in all regions which showed clearly that economies could be obtained and efficiency increased by changing over from steam to diesel traction in many of the larger marshalling yards and goods depots. By the introduction of the proposed 573 diesel-engined locomotives some 635 life-expired steam locomotives will be replaced. Under the replacement scheme there will be introduced 432 diesel-electric units of 350 h.p. and 141 diesel-mechanical units of 150/200 h.p. As a first instalment, under the 1953 renewal programme, fifty-seven diesel-electric and twelve diesel-mechanical units will be introduced. The diesel-electric locomotives will be of the 0–6–0 class, and there will be two classes of diesel-mechanical engines, 0–4–0 of 150 h.p., and 0–6–0 of 200 h.p. We understand that the balance of the proposed 141 diesel-mechanical units will be subject to the performance of the first twelve in service. It is proposed to build the main frames, wheels, cab structures and mechanical parts of the new locomotives in British Railways workshops and purchase the engines and transmission equipment from specialist manufacturers.

BOOKS RECEIVED

Thermodynamics. By George A. Hawkins. Second edition. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 52s.

Oxide-Coated Cathode: Vol. II, Physics. Translated by S. Wagener. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 42s.

A.C./D.C. Test Meters. By W. H. Cazaly and Thomas Roddam. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 18s.

Thermal Stresses in a Rotating Elastic Solid of Revolution

By C. E. ILIFFE, M.A., A.M.I.Mech.E.*

Introduction by Dr. A. T. Bowden

THIS article is concerned with stresses in an elastic solid of revolution of the most general shape. In 1943, Southwell gave a solution for the stresses in such a solid at uniform temperature, which was designed to be readily adaptable to the relaxation technique. The present paper, which was completed, apart from the example, in July, 1950, regards Southwell's solution in effect, as a "complementary function," and shows how a "particular integral" can be derived which, when added to Southwell's solution, will enable steady state thermal stresses to be determined. In other words, the method of the article consists in adding thermal stress terms to Southwell's expressions for the stresses and boundary conditions, whilst retaining Southwell's governing equations for the stress functions unchanged.

In January, 1951, a letter dated September, 1950, appeared in *Nature* from R. D. Hoyle, giving the brief outlines of an alternative approach to the problem. This approach, however, is valid not only for steady state temperature distributions, but for transient ones as well. Hoyle has used new stress functions, the governing equations of which involve a temperature term. For a uniform temperature distribution Hoyle's solution, like that of the present paper, becomes identical with Southwell's. For a steady state temperature distribution, however, the temperature terms in Hoyle's governing equations do not necessarily vanish, so that Hoyle's method and that of the present article are essentially different.

Methods of calculating the stresses in a rotating elastic solid of revolution have been known for some time, notably that given by Southwell.[1, 2] With the advent of the gas turbine, the problem of determining the thermal stresses in such a solid has assumed considerable importance. The present paper puts forward a solution to this problem for a "steady state" distribution of temperature—that is, for conditions under which the temperature at any point of the solid has become independent of time. Such a distribution is of interest, determining as it does the thermal stresses in a turbine spindle in its normal running condition. It is also far more simple to calculate than are transient distributions.

Notation

T = temperature above uniform value corresponding to unstressed state.
E = Young's Modulus (assumed independent of T).
σ = Poisson's Ratio.
α = temperature coefficient of expansion (assumed independent of T).
μ = mass density.
r = radial distance from axis.
θ = angle between radius r and datum plane through axis.
z = distance along axis from origin.
$\widehat{rr}$, $\widehat{\theta\theta}$, $\widehat{zz}$ = normal tensile stresses in directions of r, θ and z respectively.
$\overline{R}$, $\overline{\Theta}$, $\overline{Z}$ = boundary tractions in directions of r, θ and z respectively.
$\widehat{rz}$ = shear stress in direction of r on plane having normal in direction of z.
$\Omega = \widehat{rr} + \widehat{\theta\theta} + \widehat{zz}$.
l, m, n = direction cosines of outward normal to surface with reference to r—, θ—, z— directions respectively.
$\beta = \cos^{-1} l$.
r_0 = outside radius of solid.
$\rho = r/r_0$.
$\zeta = z/r_0$.
T_0 = temperature at $(r, z) = (r_0, o)$.
ω = angular velocity of solid.
χ, ψ = stress functions defined by equations (10).
ν, τ = co-ordinates defined by equations (11).

$$\Psi^2 = \frac{\partial^2}{\partial\rho^2} - \frac{1}{\rho}\frac{\partial}{\partial\rho} + \frac{\partial^2}{\partial\zeta^2}.$$

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Governing Equations and Boundary Conditions

Any steady state temperature distribution is governed by the relation

$$\nabla^2 T = 0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For the case of a stationary elastic solid of revolution subject to such a temperature distribution, therefore, the equilibrium equations reduce to

$$\left.\begin{aligned} \frac{\partial}{\partial r}\widehat{rr} + \frac{1}{r}(\widehat{rr} - \widehat{\theta\theta}) + \frac{\partial}{\partial z}\widehat{rz} = 0 \quad (a)\\ \frac{\partial}{\partial r}\widehat{rz} + \frac{1}{r}\widehat{rz} + \frac{\partial}{\partial z}\widehat{zz} = 0 \quad (b)\end{aligned}\right\}$$
$$. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

whilst the compatibility equations become

$$\left.\begin{aligned} \nabla^2(\widehat{rr} + \widehat{\theta\theta}) + \left(\nabla^2 - \frac{\partial^2}{\partial z^2}\right)\frac{\Omega}{1+\sigma} = \frac{E\alpha}{1+\sigma}\frac{\partial^2 T}{\partial z^2} \quad (a)\\ \left(\nabla^2 - \frac{4}{r^2}\right)(\widehat{rr} - \widehat{\theta\theta}) + \left(\frac{\partial^2}{\partial r^2} - \frac{1}{r}\frac{\partial}{\partial r}\right)\frac{\Omega}{1+\sigma} = -\frac{E\alpha}{1+\sigma}\left(\frac{\partial^2 T}{\partial r^2} - \frac{1}{r}\frac{\partial T}{\partial r}\right) \quad (b)\\ \nabla^2\widehat{zz} + \frac{\partial^2}{\partial z^2}\left(\frac{\Omega}{1+\sigma}\right) = -\frac{E\alpha}{1+\sigma}\frac{\partial^2 T}{\partial z^2} \quad (c)\\ \left(\nabla^2 - \frac{1}{r^2}\right)\widehat{rz} + \frac{\partial^2}{\partial r\partial z}\left(\frac{\Omega}{1+\sigma}\right) = -\frac{E\alpha}{1+\sigma}\frac{\partial^2 T}{\partial r\partial z} \quad (d)\end{aligned}\right\}$$
$$. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where Ω denotes the invariant $\widehat{rr} + \widehat{\theta\theta} + \widehat{zz}$.

If l, m, n are the direction cosines of the normal to the surface with reference to the r—, θ—, and z— directions respectively, then, noting that $m = 0$, and introducing the relations

$$\left.\begin{aligned} l = \cos\beta\\ n = \sin\beta\end{aligned}\right\}$$

the boundary conditions subject to which equations (2) and (3) are to be solved may be written:

$$\left.\begin{aligned} \overline{R} = \widehat{rr}\cos\beta + \widehat{rz}\sin\beta\\ \overline{Z} = \widehat{zz}\sin\beta + \widehat{rz}\cos\beta\end{aligned}\right\}$$
$$. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Solution for Solid of Thickness Decreasing with r from $r = 0$.

In order to obtain a particular solution, set

$$\left.\begin{aligned} \widehat{zz} = \widehat{rz} = 0\\ \widehat{rr} + \widehat{\theta\theta} = -E\alpha T\end{aligned}\right\}$$
$$. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

thereby satisfying equations (2) (*b*), (3) (*a*), (3) (*c*) and (3) (*d*). The remaining equations now become:

$$\left.\begin{aligned} \frac{\partial}{\partial r}(\widehat{rr} - \widehat{\theta\theta}) + \frac{2}{r}(\widehat{rr} - \widehat{\theta\theta}) = E\alpha\frac{\partial T}{\partial r} \quad (a)\\ \left(\nabla^2 - \frac{4}{r^2}\right)(\widehat{rr} - \widehat{\theta\theta}) = 0 \quad (b)\end{aligned}\right\}$$
$$. \quad . \quad . \quad . \quad . \quad . \quad (6)$$

A solution of (5) (*a*) is readily found to be

$$\widehat{rr} - \widehat{\theta\theta} = \frac{E\alpha}{r^3}\int_0^r r^3\frac{\partial T}{\partial r}\partial r$$
$$. \quad . \quad . \quad . \quad . \quad . \quad (7)$$

which, when substituted in (5) (*b*), leads to the result

$$r^3\left(\frac{\partial^2 T}{\partial r^2} - \frac{1}{r}\frac{\partial T}{\partial r}\right) + \int_0^r r^3\frac{\partial^3 T}{\partial r\partial z^2}\partial r = 0,$$

That is, to

$$\int_0^r r^3\frac{\partial}{\partial r}(\nabla^2 T)\partial r = 0$$

which reduces to an identity. Equations (5) and (7) thus constitute a particular solution of equations (2) and (3) corresponding to the boundary conditions

$$\left.\begin{aligned} \overline{R} = \frac{1}{2}E\alpha\left(\frac{1}{r^2}\int_0^r r^3\frac{\partial T}{\partial r}\partial r - T\right)\cos\beta\\ \overline{Z} = 0.\end{aligned}\right\}$$
$$. \quad . \quad . \quad . \quad . \quad . \quad (8)$$

In order that the integration in equations (7) and (8) may be performed, the thickness of the solid must decrease with r from $r = 0$,

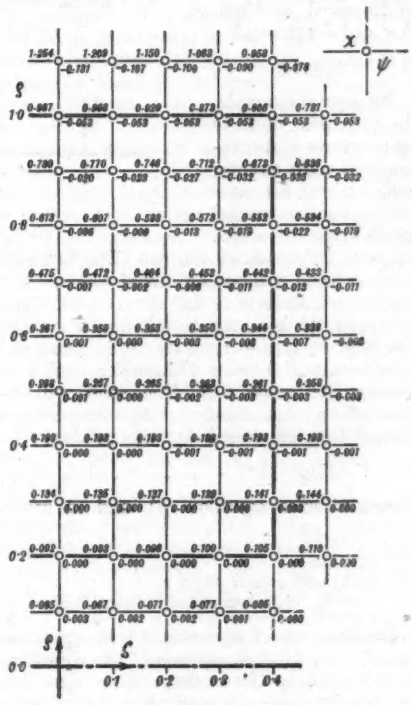

FIG. 1

or, in the limit, remain constant. With this proviso, the addition of equations (5), (7) and (8) to the corresponding equations in a known complete solution for a stationary or rotating elastic solid of revolution at uniform temperature yields a complete solution for such a solid with steady state temperature distribution. A complete solution for the case of uniform temperature with or without rotation has been given by Southwell.[1]

Extension of Solution to Solid of Any Shape

A solid of revolution which does not meet the condition of thickness decreasing with r from $r = 0$ is first supposed to form part of a fictitious solid in which this condition is fulfilled. The isothermals in the region of the given solid are then produced where

necessary to the boundary of this fictitious solid, subsequently being adjusted, by use of the relaxation technique, for instance, to satisfy equation (1). The integration in (7) and (8) is now performed over the fictitious solid, $\bar{R}$ being evaluated at the boundary of the given solid.

This device amounts to that of cutting the given solid out of the fictitious one and replacing the effect previously exerted on it by the remnant by appropriate boundary tractions.

The solution described above for inertia and thermal stresses combined may readily be thrown into a form suitable for numerical evaluation by the relaxation technique as described by Allen, Fox and Southwell.[2]

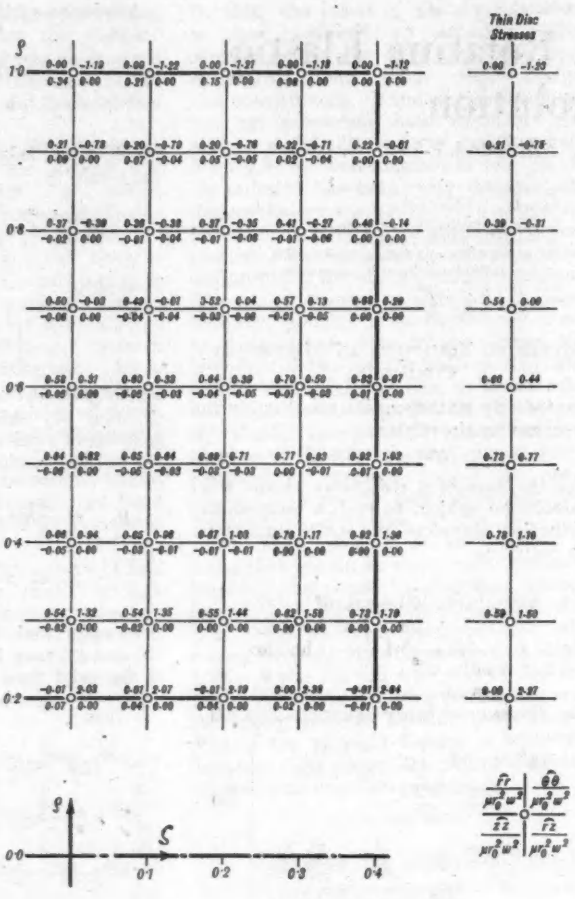

FIG. 2

EXAMPLE

By way of example, the stresses due to temperature and rotation in a right circular cylinder with an axial hole will be determined for the case in which the boundary tractions are zero. The fictitious solid is then without an axial hole, but otherwise identical to the given solid. The radius of the hole will be taken as 0·2 times the outside radius r_o of the solid, the axial thickness as 0·8 times this radius, and σ as having the value 0·3. The solid will be subject to the steady state temperature distribution expressed by the relation:

$$T=T_o(\rho^2-2\zeta^2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

which satisfies equation (1), and in which

$\rho=r/r_o$
$\zeta=z/r_o$
T_o = temperature at (r, z)
$=(r_o, 0)$, taken equal to $3\mu r_o^2\omega^2/E\alpha$.

Substitution of equation (9) in equations (5), (7) and (8) and addition of the equations so obtained to the corresponding equations in Southwell's solution[1] for the stresses in a rotating elastic solid of revolution at uniform temperature, as modified[2] for application of the relaxation technique, leads to the relations:

$$\left.\begin{aligned}
\frac{\widehat{rr}}{\mu r_o^2\omega^2}&=\frac{1}{\rho}\frac{\partial\chi}{\partial\rho}+\frac{1}{\rho}\frac{\partial\psi}{\partial\rho}-\frac{1}{\rho^2}[(1-\sigma)\chi+\psi]-\\
&\qquad\frac{3-2\sigma}{8(1-\sigma)}\rho^2+\frac{E\alpha T_o}{\mu r_o^2\omega^2}\left(\zeta^2-\frac{\rho^2}{4}\right)\\
\frac{\widehat{\theta\theta}}{\mu r_o^2\omega^2}&=\frac{\sigma}{\rho}\frac{\partial\chi}{\partial\rho}+\frac{1}{\rho^2}[(1-\sigma)\chi+\psi]-\\
&\qquad\frac{1+2\sigma}{8(1-\sigma)}\rho^2+\frac{E\alpha T_o}{\mu r_o^2\omega^2}\left(\zeta^2-\frac{3}{4}\rho^2\right)\\
\frac{\widehat{zz}}{\mu r_o^2\omega^2}&=-\frac{1}{\rho}\frac{\partial\psi}{\partial\rho}-\frac{\sigma}{2(1-\sigma)}\rho^2\\
\frac{\widehat{rz}}{\mu r_o^2\omega^2}&=\frac{1}{\rho}\frac{\partial\psi}{\partial\zeta}
\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

In this equation . . . 10

$$\left.\begin{aligned}\theta^2\chi&=0\\ \theta^2\psi&=\frac{\partial^2\chi}{\partial\zeta^2}\end{aligned}\right\}$$

where

$$\theta^2=\frac{\partial^2}{\partial\rho^2}-\frac{1}{\rho}\frac{\partial}{\partial\rho}+\frac{\partial^2}{\partial\zeta^2},$$

subject to the boundary conditions,

$$\left.\begin{aligned}
0&=\frac{\partial}{\partial\nu}\left(\frac{\psi}{\rho}\right)+\cos\beta\left(\frac{\partial}{\partial\rho}+\frac{\sigma}{\rho}\right)\frac{\chi}{\rho}-\\
&\qquad\frac{3-2\sigma}{8(1-\sigma)}\rho^2\cos\beta+\frac{E\alpha T_o}{\mu r_o^2\omega^2}\left(\zeta^2-\frac{\rho^2}{4}\right)\cos\beta\\
\psi&=-\frac{\sigma}{2(1-\sigma)}\int_o^\tau\rho^2\sin\beta\,\partial\tau
\end{aligned}\right\}$$

where

$$\left.\begin{aligned}\nu&=\rho\cos\beta+\zeta\sin\beta\\ \tau&=\rho\sin\beta-\zeta\cos\beta\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Employing the relaxation technique, the solutions for χ and ψ illustrated by Fig. 1 have been obtained. From these solutions the stresses have been evaluated by means of equations (10), with the results shown in Fig. 2. These stresses are seen to satisfy the boundary conditions within the limits $\pm 0\cdot01\mu r_o^2\omega^2$.

If any section of the given solid at right angles to the axis were regarded as a thin parallel-sided disc, the stress distribution in such a disc would be found to be the same for all such sections. This two-dimensional stress system is shown in Fig. 2 as a further check on the validity of the method of stress calculation forming the subject of this paper.

ACKNOWLEDGMENT

The author wishes to express his thanks to the directors of C. A. Parsons and Co., Ltd., for their kind permission to publish this work.

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[1] Southwell, "Some Practically Important Stress Systems in Solids of Revolution," "Proc.," Roy. Soc., Vol. 180, Series A, page 367, 1942.

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The Factory Act and Employers' Liability

By SIR WILLIAM BALL, O.B.E.

IN an article which appeared in the columns of THE ENGINEER in March, 1949, I discussed the question "What is the position of an employer as regards injury to those whom he employs, having regard to recent legislation?"

There was then some reason to hope that liability for industrial injuries having been assumed by the State, the number of actions brought against employers would diminish. They have become fewer, of course; nevertheless, a glance through the *Law Reports* of the last two years serves to show that the injured workman is not always content with what he can get from the Insurance Commissioners. It is evident that he is often prepared (if he can) to make a claim for damages at common law.

Broadly speaking, a claim against the Commissioners can be supported on grounds similar to those which availed a plaintiff bringing an action under the Workmen's Compensation Acts. Between that and a claim at common law there was a vital distinction: an injured workman was entitled to "compensation" for injury by accident arising out of and in the course of his employment, without having to prove negligence on the part of the employer; and even when the "Compensation" Acts were in force he could, if so minded, elect to bring his action at common law and could succeed if negligence were proved. So he can to-day; and there is something to induce him to proceed with such an action. If he obtains judgment, he is awarded a lump sum. On the other hand, the amount under the National Insurance Act can only be met by a weekly payment of 45s.

Nor does the fact that he has made a successful claim against the Commissioners prevent him bringing an action as well. The Insurance Act, it is true, may have effect to abate, to a small extent, the damages which an employer may have to pay when he is held liable; but when one has regard to the very large sums which judges have awarded to an injured man, or to his widow if the accident has resulted in his death, it is not surprising to find that employers often have to figure as defendants in the Law Courts.

I now propose to consider some recent cases in which it has been sought to enforce the liability of an employer at common law. Such an action may be founded on (i) negligence or (ii) breach of statutory duty. As to

actions merely founded on negligence, it is the fact that they are comparatively rare. This is because it is not easy to prove negligence. After all, every man of full age who undertakes to do a job must be taken to accept a certain amount of risk. As the lawyers say, *volenti non fit injuria*. If I employ a mason to build a wall, and a brick falls on his head, that is a risk which he has to run.

But where an accident occurs as the result of a breach of some statute or statutory regulation, the position is quite different. If he has failed to "comply with the rules" the employer is liable.

It is when an accident occurs in a factory that the person injured has the best chance of succeeding when he makes a claim based upon the breach of a statute or statutory regulation.

What, then, is a "factory"?

It is at any rate clear that the Courts will not lightly hold a place to be a "factory" unless it bears some resemblance to what the "man in the street" would look upon as a factory.

In the case of Joyce *v.* Boots Cash Chemists (Southern), Ltd., (1950) 2 All E.R. 719, it was sought to make the defendants liable for an accident which occurred on their premises which were alleged to be a "factory" within the meaning of Sec. 151 of the Factories Act, 1937. It was said that they had been guilty of negligence or breach of statutory duty. The plaintiff was employed as a porter, whose duty it was to load and unload vans, carry goods and bottles up and down stairs, clean windows, and weigh out commodities for sale. While carrying a box to the stairs he tripped over a piece of linoleum, fell, and sustained injuries. It was alleged that the employers were negligent because they had not provided a handrail, which would have enabled the plaintiff to save himself from falling. On this point, however, the judge decided that there was no evidence of negligence, holding that the plaintiff had not discharged the onus of showing that provision of a handrail would have prevented the accident.

But the learned judge also decided that the premises were not a factory. He pointed out that the word "factory," for the purposes of the Act of 1937, has no relation to the dictionary or the colloquial definition. Indeed, the statutory definition is so elaborate that the legislature might have been better advised to explain what is *not* rather than what *is* a factory. But, fortunately for the defendants, the plaintiff had to show that the accident took place on premises where "persons are employed in manual labour in any process for or incidental to" certain purposes. Those purposes include the "making of any article or part of any article" and "the adapting for sale of any article." In fact the only person on the premises who, besides the plaintiff, could be said to be engaged in "manual labour" was a chemist, who compounded medicines and rolled pills. The learned judge, however, very reasonably found that his work was substantially intellectual and the use of his hands only subsidiary. As to the plaintiff himself, it was true that he had to do a certain amount of manual labour. But the judge said: "It seems to me to be almost fantastic to suggest that merely because the plaintiff is employed as a porter at this ordinary chemists' shop, the shop becomes a factory, but would cease to be a factory the moment the plaintiff left." Had the learned judge decided otherwise every retail shop in the kingdom would become a factory!

When it is alleged that the occupier has committed an offence of some kind, the terms of the Act will be strictly construed. For instance, it is provided by Sec. 26 (1) that a safe means of access to every place at which any person has at any time to work shall be provided and maintained. What does this mean? It may be that a man employed to do a particular job has to move from one place to another while doing his work. Must there be a safe means of access from one part of the job to another? This question was answered by the Court of Appeal in Dorman, Long and Co., Ltd., *v.* Hillier (1951), 1 All E.R., 357. In that case the plaintiff was employed to strip corrugated iron sheets off a roof. Access to the roof was by a ladder and then by treading on purlin bars. Having reached the roof and removed one sheet, the man stood on a purlin bar to remove another. He stepped back and put his foot on another sheet which was unsafe. In the result he fell and was killed. In these circumstances it was held that no offence against the regulations had been committed. The Master of the Rolls pointed out that there might be cases in which the work was divided into different "branches," and it might be that there should be safe means of access from one branch to another. But here the man had got to the place where he had to work and was actually working. But one of the other members of the Court was careful to point out that "a place may at one and the same time be a place of work and a means of access."

The extent to which the legislature has gone in order to impose liability on the occupier of a factory was well illustrated in the case of Whincup *v.* Joseph Woodhead Engineers, Ltd., and Another (1951), 1 All E.R. 387. The occupiers of a factory (Joseph Woodhead and Sons) employed the firm of J. W. Harrison, Ltd., to repair some panes of glass in the roof of the factory. The plaintiff, who was employed by the latter firm, was injured when doing his work. He brought an action against both firms. The judge found that the accident was caused owing to there being no safe means of access to the work, as provided for by certain building regulations made pursuant to the Factories Act, 1948. Sec. 14 (4) of that act provides that its provisions shall apply "to building operations as if any place where such operations are carried on were a factory, and any person undertaking any such operations to which this Act applies were the occupier of a factory." In these circumstances it is not surprising that Messrs. Woodhead sought to escape liability, saying (in effect) that there could not be two occupiers of the same "factory," each saddled with liability. But the judge having considered all the relevant statutes held that they, too, were liable, saying that the effect of the Act of 1948 was not intended to relieve occupiers from the obligation imposed on them by the Factories Act of 1937. In the end he held *both* firms liable, making them each pay half.

Many a "factory case" is based upon an allegation that some machine was inadequately fenced, and it seems to be the fact that even in the absence of direct evidence the judges will assume that it was the absence of a guard that caused the accident. This is well illustrated by the case of Thorogood *v.* Van den Bergs and Jurgens, Ltd. (1951) 1 All E.R. 683. The plaintiff was employed as an electrician by the defendants in their margarine factory. He was working in a separate building where machinery used in the various processes was sent for repair. While testing a fan he caught his hand in one of the rotating blades and was injured. He brought an action for damages, basing his claim on the absence of a guard as provided for in the Factory Act, and also on the alleged negligence of the employers. When giving evidence he said he could not remember how his hand was caught in the fan, and the court took the view that it resulted from some inadvertence on his part. It was held by the Court of Appeal that the repair shop was part of the margarine factory because the repair of machinery was incidental to the manufacture of margarine. That being so, the employers were bound to fence the machine, and were liable for the consequences of not doing so. But they were also held to have been guilty of negligence at common law. In the course of his judgment, Lord Justice Asquith said: "Although reasonable foresight of possible injury is the true criterion where negligence or not is the issue, an employer who has created or permitted a dangerous condition to arise is reasonably expected to foresee and provide against the possibility of injury resulting therefrom, even though it results through the intermediation of an act of inadvertence by the employee and even though that act of inadvertence be of a character which cannot be precisely forecast and remains in the event unexplained." It is interesting to note that in coming to the conclusion that here the employers were negligent, the Court of Appeal overruled Mr. Justice Devlin, who held they were not. And so it is a point upon which lawyers differed, and well they might. In the testing of many a machine the element of danger is always present. Ought the employers, in the present case, have seen to it that a guard was provided and ready to be put in place whenever the fan was set in motion? Any layman might be excused if he failed to understand the decision of the Court of Appeal after hearing from the injured man himself that he was wholly unable to explain how the accident happened. Take the simple case of a circular saw which is properly guarded according to the regulations. A man using it has one of his fingers cut off, but is wholly unable to explain how they came in contact with the teeth of the saw. As it seems to me, if the reasoning of Lord Justice Asquith is applied, the employers might in such a case be held liable for negligence.

It might be thought that by employing a competent sub-contractor, who should observe the regulations, a contractor would himself escape liability. But this was held not to be so in the case of Pratt *v.* Richards (1951, 1 T.L.R. 515); a building company, who were erecting houses, employed contractors to tile the roofs, the builders having to supply and erect and maintain the scaffolding necessary to maintain the work. The contractors, in their turn, engaged a sub-contractor to do the actual tiling. The scaffolding from which the workmen erected the roof had no guard and was 15ft 2in from the ground. A workman employed by the "tilers," when climbing down from the roof fell to the ground and was killed. His widow brought an action against the builders, the contractors and the tilers. It was held that the death had been caused by the absence of a guard rail; that the contractors were liable, both for a breach of the regulations in failing to provide a guard rail, and because they had failed to take reasonable care to provide proper plant; that the builders were also liable because they owed a duty to the workmen employed by the contractors. The tilers, however, were held blameless because there was no relationship of master and servant between them and the injured workmen. In the result the widow recovered the sum of £1950 from the

builders and the contractors, who, presumably, would each be liable for half that sum.

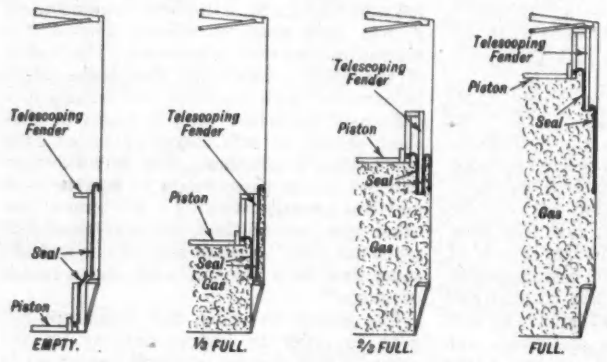
But it is gratifying to find that the judges are often guided not merely by the opinions of their predecessors, but by the dictates of common sense. Instance the case of Beadsley and Os. *v.* United Steel Companies, Ltd. (1950) 2 All E.R. 872. In that case it was alleged that the defendants were in breach of their duty to a man who was killed when a heavy mould came adrift from its fastenings and fell on him. His widow claimed damages. It was proved at the trial that proper lifting tackle was provided by the defendants, but on the day of the accident the slinger did not use it. He lifted the mould with other gear, so that it fell out of its fastenings when the overhead crane was set in motion.

I have, however, said enough to show that in their interpretation of the law as applied to factories the Courts nearly always follow the rule: "Breach of regulation: liability," as a matter of course. There is nothing in the Factory Acts which will serve to excuse an employer if it be proved that he has done all that can reasonably be required of him. In this respect the position of an ordinary employer compares unfavourably with that of a coalowner (now, indeed, the Coal Board) in regard, at any rate, to one source of danger in the mine. Those responsible for making regulations as to the use of explosives in mines were fully aware of the fact that if the mine manager has done his best to see that those who handle explosives have conformed to the rules, neither he nor those who employ him can be held liable for an accident. In the case of Harrison *v.* National Coal Board (1951, 1 T.L.R. 1079) a collier brought an action for damages sustained when a shot was fired before he had been warned to get out of the danger zone. By the terms of the Coal Mines Order, 1934, the shot firer is bound to see that all persons in the vicinity have taken proper shelter before firing the shot. It was contended that the National Coal Board, being the employers, were responsible. Regulations made under the Coal Mines Act, 1913, provide that the manager and undermanager shall "carry out and to the best of their ability enforce the provisions of every order in force under the Act regulating the supply, use and storage of explosives, and it shall be the duty of all persons employed in or about the mine to comply with the provisions of the said orders." The regulations made in 1934 provide that shot firers shall be appointed by the manager, and that no shot shall be fired by any other person. When the case was heard by Mr. Justice Jones at the Leeds Assizes, he held that the defendants took all reasonable means by publishing the regulations to secure compliance with them, and that they took all precautions to ensure that shot firing should be carried out with care. He also held that the duty imposed was merely personal to the shot firer. In the event he dismissed the action. His decision was affirmed by the Court of Appeal and by the House of Lords. Lord Porter said, when delivering his opinion: "If the owner has done his best he is neither guilty of a crime nor is he in breach of a statutory enactment. . . . In the present case, where the duty is specifically laid on the shot firer, whom the owners cannot themselves appoint and with whose activities they cannot interfere, I cannot see any reason for thinking the owners have any duty beyond that resulting from the provision of the Act." The only dissentient was Lord Reid, who was of opinion that the duty in question should be held so as to affect the Coal Board, and make them liable for its breach.

A Dry Seal Gasholder

THE first Wiggins dry seal gasholder to be erected in this country was recently constructed at Alston, in Cumberland, for the Northern Gas Board by Ashmore, Benson, Pease and Co., of Stockton-on-Tees. This atmospheric pressure type of gasholder was developed in the United States by the General American Transportation Corporation, and until recently was used mainly for the storage of petroleum vapours. It has now been adapted for the storage of chemical process and industrial gases at pressures up to 20in w.g.

In these piston displacement gasholders the sealing medium used to prevent the escape of gas through the annular space between the piston and the shell of the unit is a flexible impermeable synthetic rubber-coated fabric—usually asbestos cloth impregnated and coated with neoprene. The asbestos cloth used is so made to give the strength required with a weave which will permit the coating to key through the cloth to give the maximum peel strength. Neoprene is used because of its high resistance to ageing, and chemical reaction.



OPERATION OF DRY SEAL GASHOLDER

In the diagram we reproduce on this page the arrangement and operation of the seal can be clearly seen. The seal is in the form of a flexible cylinder, the lowermost edge of which is joined by means of gastight closures to the piston and the uppermost edge to the inner wall of the holder shell about halfway up its height. About midway up its height the seal is attached to a telescoping fender, which serves to prevent the rim of the piston rubbing on the seal as it ascends. Concrete blocks are used as weights on the top of the piston to give the required operating gas pressure, and when the gasholder is empty the piston rests on the shell bottom.

DRY SEAL GASHOLDER AT ALSTON

The makers state that the volume of gas confined within the loops of the seal is less than 0·5 per cent of the storage capacity of the holder, and this permits quick and thorough purging.

As gas enters the holder the seal is first inflated and assumes an upward looped position, the pressure required for this being about ¼in w.g. When sufficient gas has been pumped the piston begins to rise and its fender meets the outer telescoping fender at a point about one-third up the height of the shell. As the piston continues to rise the seal rolls off the piston fender on to the telescoping fender without rubbing or abrasion. The piston and the telescoping fenders rise as a single element until full storage capacity is reached.

It will be appreciated that with this design and method of operation the need for close manufacturing tolerances is eliminated and no roller guides or centring gear is needed, as the seal automatically positions the piston and prevents it from rotating.

The new gasholder at Alston is shown in the illustration below. It is 29ft diameter and adds 10,000 cubic feet to the coal gas storage facilities in the area. The site of the gasholder is very exposed, but as the fabric seal has an operating temperature range from minus 40 deg. to plus 180 deg. Fah., the weather will not affect its efficient operation. A further advantage the holder has for this type of site is that the piston and seals are completely protected from snow, ice and rain, and the external parts of the balancing system are designed to withstand all hazards of winter weather. The necessity for cold weather protection against freezing seals is eliminated and with it the cost of heating or treating the sealing medium. The complete ventilation of the free space above the piston is by means of louvres spaced around the walls above the seal, and the gasholder will not have to be taken out of service for inspection, as access doors and ladders allow inspection of all moving parts in the completely ventilated space above the piston.

This holder at Alston has been arranged to throw 6in w.g. pressure and concrete blocks have been provided for loading on to the piston to increase this to 8in w.g. should the necessity arise.

Erection of the holder was begun on September 1, 1951, and it was ready for testing in the remarkably short time of eight weeks. The makers point out that simplicity in design was a contributing factor to the speed of completion, and the elimination of the heavy foundations required by the traditional kinds of holders also assisted in reducing the constructional period as well as the cost. The foundations, which took about a fortnight to lay prior to the commencement of erection, were built by a local firm.

BLANKETING ON THE WESTERN REGION.—It is announced by the Western Region of British Railways that blanketing of five separate sections of the up line, totalling 145 chains and spread over a distance of 10 miles between Westbury (Heywood Road Junction) and Patney and Chirton, has recently been completed. When this work was planned it was estimated that if it was to be carried out under long week-end occupations it would take twenty-two weeks, during which a severe speed restriction would have been imposed. For this reason the operating department agreed to close the line for four weeks and divert traffic except for certain trains over the down line, between 10 p.m. and 6 a.m. each night. This arrangement enabled the work to be carried out continuously, with consequent saving in time and cost.

Eight Automobiles

(From our American Correspondent)

AN unusual exhibition, entitled "Eight Automobiles," which opened a few weeks ago at the Museum of Modern Art in New York, was concerned with the æsthetics of motor-car design, approving the body styling of certain British and Continental manufacturers, while rejecting emphatically what has become known throughout the world as the "dollar grin." Eight vehicles were selected by the museum to form a nucleus of the exhibition. The eight automobiles were chosen primarily for their excellence as works of art, although no car was considered for inclusion unless its mechanical performance met the highest technological standards. A second consideration was their relevance to contemporary problems of passenger car design. The older cars, dating back as much as twenty years, were chosen not to show historical progression, but to show prototypes of design that are still valid to-day. Racing cars and limousines, and experimental or unique cars, however beautiful or historically influential, were not the concern of the exhibition and therefore were not included.

A 1930 Mercedes-Benz, Model SS, the oldest car shown, is representative of the classic vehicle considered as four large wheels carrying a box. A 1937 Cord exhibits a most solemn expression of streamlining, with many of its lines obviously suggesting the influence of aerodynamics. A 1939 Bentley is a fine example of the "razor-edge" trend. It is appropriately described as a carefully groomed object—rigid, poised, powerful—with a patrician urbanity of style other schools of design have failed to render obsolete. A 1939 French Talbot is a particularly successful example of a streamlined body which allows secondary parts joined to the body to remain clearly defined. The 1941 Lincoln Continental is perhaps the most "un-American" car produced in the United States during the last decade and is considered to satisfy the requirements of connoisseurs while capturing the imagination of a public less preoccupied with the refinements of automobile design. The designers of the 1948 MG, Model TC, are complimented for having chosen simply to elaborate the look of a machine and having appropriately used toward this end a few concise details to convey a quantity of information. The body of the 1949 Cisitalia displays a real sculptural unity of its entire shape and is aptly said to have been slipped over its chassis like a dust cover over a book. Finally, the 1951 Jeep was selected as a beautiful tool for transportation, being one of the few genuine expressions of machine art, developed by engineers working without the concern for style that distinguishes other motor-cars.

With these ideas in mind, the exhibition turned to look at recent American mass-produced cars considering the most satisfactory of them to be the 1949 Ford, the 1947 Studebaker, the 1938 Lincoln Zephyr, and the 1939 Cadillac 60 Special. Even though the American system of mass production does not encourage æsthetic speculation, these cars are believed to contradict the claim that the American public prefers what is ugly, gross, or even vulgar. Popularity polls, which pretend to discover public taste, are often testing only the efficiency of advertising. It is true that the furious productivity of modern factory methods is sustained, in part, by making the automobile a symbol of wealth and social position. The value of that symbol is renewed from year to year by what is known as artificial obsolescence, forcing arbitrary changes in what may be already satisfactory designs. But quite often American cars fail to be enhanced by fresh applications of chromium. The "dollar grin" does not represent Detroit's best effort.

Controlled Density Steel*

THE Ontario Research Foundation has developed a process and methods for producing finished and semi-finished articles of steel having any desired density and analysis within a very wide range. The process itself is extremely simple. Fine iron ore is made directly into the desired steel shape without melting or any other intermediate step. The dry, fine, prepared ore, generally finer than 60 mesh, is poured directly into suitable moulds, is then reduced at a temperature of about 2000 deg. Fah. and is finally held for a longer treatment time of several hours at this same temperature. The resulting article has the composition and structure of normal steel except that it contains a predetermined amount of spherical voids which are not interconnected. This point is most important, since the cellular structure of the steel allows it to be heated and hot-worked without any great precautions being necessary to prevent excessive oxidation and scaling.

The future applications of this new engineering material have been divided into three classes, according to density. The density of steel is about 7·8g per cubic centimetre. Controlled density steel can be produced with any desired density from 1·0 to 7·2 directly from the furnace.

HOT WORKED MATERIAL

Controlled density steel may be produced with carbon contents ranging from less than 0·01 up to 1·5 per cent. Alloying additions can also be made to the ore and a wide variety of alloys have already been produced by this method. If the final form of the steel is to be rods, bars or wire, the iron ore is poured into a paper tube or some type of porous mould such as a Croning sand mould or porous graphite mould. The tubes full of ore are placed in a metal or ceramic sagger which is then filled with a mixture of coke breeze and limestone and sealed. The loaded container is then heated to 2000 deg. Fah. and held for sufficient time to produce the desired carbon content and density. The density of the finished article will depend upon the swelling or shrinking characteristics of the iron ore employed, on the maximum particle size and on the particle size distribution. For hot working the density of the steel coming from the furnace must be more than 3·0 and is preferably over 4·0.

The resulting bars are removed from the saggers after they have cooled to about 100 deg. Fah. The bars may then be reheated and hot-worked by swaging. When reduced in cross-sectional area by more than 80 per cent in the hot swaging operation the tensile properties, elongation, reduction of area and hardness of the bars correspond closely to the mechanical properties of ordinary steel of the same composition in the same stage of processing. The bars or rods can then be further cold worked and will attain the normal mechanical properties for cold drawn steel bars of the same analysis. Hot working and forging of other shapes can also be carried on quite easily as long as the shape is totally enclosed on at least four sides during working. The first working must be very gentle, but once a density of 7·5 or more has been obtained, hot working may proceed in the same way as with ordinary steel. The usual methods of annealing, hardening and subsequently bringing the steel to the desired physical properties are the same as with ordinary steel.

It is believed that the cost of producing such material from controlled density steel will be higher than that of producing ordinary steel bars when the material is produced at the rate of about 20 tons per day from a continuous type of operation. There is no possibility that this process will compete with standard methods of producing steel on a large tonnage basis but it has interesting possibilities in locations remote from present steel plants, but close to suitable ore. It is also of interest in plants using 10 to 20 tons per day of steel who may find it advantageous to have their own closely controlled source of raw material, such as bar stock, tubing or sheet.

SUBSTITUTE FOR IRON POWDER

Controlled density steel in the range from 4·0 to 6·5 can be produced with about the same mechanical properties and composition as pressed iron powder products. In this field the process is in direct competition with powder metallurgy. Its use is attractive where the parts being produced do not require much machining after coming from the furnace. This means that such intricate parts as gears could not be made at a competitive price by this process as compared to pressed and sintered powder gears. The tolerances on the parts as produced are not of the order of pressed powder tolerances, but rather in the range of casting tolerances. The process should be regarded as a "casting" method, since many parts can be produced from moulds which could not be pressed from powder. Where moulds can be designed to be filled with dry ore powder, steel parts can be produced which require about the same amount of finishing as a cast iron or cast steel part.

In production of such simple shapes as bands, rings, bars, &c., the controlled density steel process gives lower costs than powder metallurgy methods where the amount of finish machining to be done is low and especially where required dimensional tolerances are not extremely rigid.

LIGHT STEEL

Light steel would seem to be a suitable name for the third class of controlled density steel products. In the range of densities between 4·0 and 1·0 the main advantages of the material are its very low cost compared to other light-weight metals, and the fact that it can be produced directly from the furnace to reasonably close tolerances. In all cases the tensile strength of the material decreases with decreasing density. At a density of about 1·3 the mechanical properties compare with those of wood. At densities of 2·5 to 4·0 the tensile strength is increased to about 15,000 lb or 20,000 lb per square inch. The ductility and impact strength are low.

By proper preparation of the ore, shrinkage can be controlled to less than 1 per cent. Particularly in cases where low cost and light weight are the main considerations, light steel can replace plastics, wood and, in some cases, magnesium and aluminium. Redesign of some parts is worth while to provide more material to withstand the required loading since the cost of the resulting part may be far below the cost of a corresponding magnesium or aluminium part. Light steel is fireproof does not warp or split, and can be soldered, welded, painted and plated. The material also takes an excellent porcelein enamel coating with no preparation or undercoating. It will bond, during manufacture, to steel, refractories and abrasive materials. At the very low densities, wood screws can be driven into it by hand and it can be cut and worked with ordinary woodworking tools. The cost of light steel parts compares with the cost of the same part made of malleable iron.

Work started on this process in May, 1951. The laboratory phase of the investigation has been completed and an exploratory pilot run is now under way in an electrically heated tunnel kiln 65ft long. The purpose of this first phase of the pilot operation is to explore the possible applications of the process. The next stage will be to get accurate production rates and costs.

It will be readily understood that other methods of reduction are quite practical. For example, extruded bars of iron oxide may be reduced in hydrogen or other reducing gases. If a very low carbon content is desired hydrogen is, of course, the preferred reducing agent. Reduction can also be carried on in a belt type furnace if the ore is in a porous mould which

*Communicated by the Ontario Research Foundation.

will support this shape as it is reduced in the furnace. Other metal oxides can also be processed in the same manner to produce shapes, finished and semi-finished articles of the resulting metal.

It is believed that this process will find a place as a supplementary method of producing many useful articles of steel. When parts as produced from the furnace are used directly without further hot or cold working it is possible to use iron ores containing large amounts of impurities which prohibit their use in normal steelmaking processes. Since the metal never passes through a liquid stage it is only necessary to keep such impurities as silica down to an acceptable level for the end use of the article. In the case of such impurities as sulphur, phosphorus, titanium, nickel and chromium, the allowable limits of these elements will be determined by the required mechanical properties of the finished article and not by their deleterious effect on the hot working properties of the steel. These facts make it possible to consider the use of many ores for the controlled density steel process which cannot be used in the standard steelmaking operations.

The object of the Ontario Research Foundation is to develop the process on a sound basis and to get it into use as soon as possible in industry. Discussions with companies interested in obtaining licences to operate the process are under way at the present. This work has been conducted under the ægis of one of the Advisory Committees of the Ontario Research Council and has been supported by funds from the Provincial Government of Ontario.

High-Speed High-Power Railway Oil Engine

§ Technical details of outstanding interest are embodied in the new quick-running, lightweight engines, intended primarily for rail traction, designed by Maybach Motorenbau and now in production at that company's Friedrichshafen works.

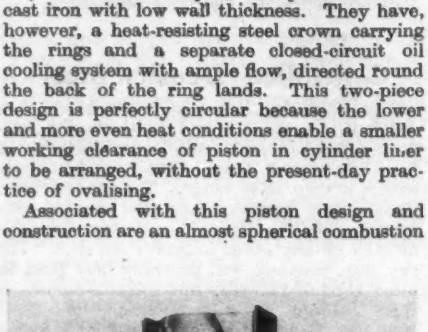
The object was to combine pre-war experience with the V-twelve-cylinder engines of 410, 450, 600 and 650 b.h.p., with the considerable amount of experience, under difficult war conditions, obtained with over 30,000 Maybach oil engines of up to 700 b.h.p., and provide an engine that would enable locomotive and railcar design to be advanced, and still continue to provide reliability and low-maintenance cost equal to the standards usually associated with slow-speed, lowly-rated and heavy engines.

An associated object was to enable a railway to meet all its motive power requirements with a series of engines having standardised constituents, and the seven engines of 300 to 1200 b.h.p. in the present range all have the same pistons, cylinder-heads, valves, rocker gear, injection pump and nozzle units, cylinder liners and main bearings, all of which are manufactured to interchangeable limits.

A primary requisite to gain high reliability and long life was felt to be a very stiff crankshaft structure. Therefore a cast iron crankcase of deep section was adopted to carry a one-piece crankshaft in which the roller main bearings encircled the crank webs. This construction gave a short engine with a small cylinder centre-to-centre distance and yet allowed ample length for the plain big-end bearings, as the webs and main journals are combined. Fork-and-blade big-ends are used and have lead-bronze bearings on steel shells.

Despite the high rating of the engine, equivalent to 150 lb brake mean pressure, and a piston speed of 2100ft per minute, at the railway continuous output, the pistons are of cast iron with low wall thickness. They have, however, a heat-resisting steel crown carrying the rings and a separate closed-circuit oil cooling system with ample flow, directed round the back of the ring lands. This two-piece design is perfectly circular because the lower and more even heat conditions enable a smaller working clearance of piston in cylinder liner to be arranged, without the present-day practice of ovalising.

Associated with this piston design and construction are an almost spherical combustion chamber in the cylinder-head and a throat of exceptionally large bore connecting it with the cylinder, and giving high combustion efficiency. A combined fuel pump and multi-hole injector unit for each cylinder is fitted and also what is probably an unusual valve arrangement, there being three inlet and three exhaust valves per cylinder, actuated by two camshafts for each cylinder bank.



12-CYLINDER, 1200 B.H.P. ENGINE

All of these design details are incorporated in the seven models listed in the accompanying table, which are available as vee, vertical or horizontal engines. The cylinders are 185mm bore by 200mm stroke (7·28in by 7·9in) and fuel consumption at the railway continuous output is 170/172 gr per b.h.p. hour, with an optimum value of 165 gr at 950/1000 b.h.p. at 1200/1250 r.p.m.

Type	Piston-swept volume, litres	Cylinder arrangement	Continuous output, b.h.p.	R.p.m.	Dry weight, lb
MD. 650	64·5	V12*	1200	1600	7900
MD. 645	64·5	V12†	800	1600	7300
MD. 435	43·0	V8*	800	1600	6600
MD. 325	32·3	6 in line*	650	1700	5700
MD. 430‡	43·0	V8†	550	1600	6000
MD. 320‡	32·3	6 in line†	450	1700	5300
MD. 215‡	21·5	4 in line†	300	1700	4000

* Pressure-charged. † Naturally-aspirated. ‡ Available as vertical or horizontal models.

Books of Reference

BEAMA Guide to British Electrodes. London: British Electrical and Allied Manufacturers' Association (Inc.), 36, Kingsway, W.C.2. Price 2s. net.—This booklet has been prepared by the Arc Welding Electrode Section of BEAMA in order to give those interested in the manual application of the electric arc welding process useful information on some general matters relating to the process. It includes a brief description of the British Classification of Electrodes, which has been published by B.S.I., and gives advice on how to use this classification. Comparisons are given of British and American electrode classification, and details of the test requirements for Lloyd's approval for electrodes and welds. Lists of mild steel electrodes made by members of the BEAMA show the British and American code numbers and Admiralty and Lloyd's approval for each type.

French Engineering News

(From our French Correspondent)

The Havre-Paris oil pipe-line, which is due to be completed at the end of 1952, has now reached the stage where a section is being sunk between Epinay and Argenteuil bridges, on the banks of the Seine. A length of 200m of pipe will be lowered on to the river bed. Between Havre and Rouen the pipe-line has been completed and only a few sections remain to be finished between Rouen and Argenteuil. So far, two river crossings of the Seine have been constructed. Once the Colombes aqueduct is built the construction of the two branches serving the Paris region will be undertaken. One will be installed towards Nanterre and will serve the aerodromes near Versailles and the other will end at Orly. There will be some 50km of distribution pipework. All the light fuels required by Paris will pass through the pipe-line, tank barges only carrying heavy fuel. The first oil is expected to pass from Havre to Paris in June-July, 1952.

* * *

A northern motorway serving Marseilles is at present under construction and the first 7km have been completed. The total length of the road will be 18km. Some 4km of the road run through built-up areas or parts of the Marseilles suburbs, which are gradually growing, and in the built-up area every effort is being made to avoid destruction of existing buildings.

The road is fairly level and it is estimated that an average speed, for private cars, of 120km per hour should be normal. The road has two 10·50m carriageways with a central grass strip

* * *

A steam generating station in Abidjan, in French West Africa, which was planned in 1935, will come into production at the end of the year. It is calculated that the total cost of the plant, 186 million francs, works out at about 45,000 francs per installed kilowatt. The usual price per kilowatt is estimated at between 70,000 and 100,000 francs. The reason given for this low cost is that the plant was planned by the administration and all the equipment was ordered by the administration instead of by the contractor.

* * *

A plan for the north of France, which should lead to decentralisation and the establishment of new towns is now being studied. The plan, if adopted, will prohibit the establishment of further industrial plant on the fringes of northern cities in general and Lille in particular. Instead the area will be divided into zones in which certain industries may be established. These zones will also be given new towns of between 50,000 and 100,000 people, and the towns linked to the industrial areas by special roads. The plan also includes the cutting of branch canals from the main northern canals so that cheap transport will be available for industry.

Local authorities are being consulted and are being asked to establish projects for their particular areas. Once these have been studied final projects will be drawn up.

* * *

Fifteen railway trucks built in an aluminium alloy and each weighing about one third that of a steel truck, which are now on show in Paris, were built for the Société de Pechiney. The frame and body of the trucks are in an alloy containing 5 per cent magnesium, 0·5 per cent manganese, and it is stated that the alloy used for the buffers and axle boxes contains 4·5 per cent copper.

The trucks, it is said, weigh about 80 tons and can carry about 65 tons or some 10 tons more than the average steel trucks.

* * *

The modernisation and re-equipping of the Gaz de France plants continues. At Chocques, in the north, the installation of new ovens has brought coke production up to 830 tons. This plant was destroyed in 1943 and after the Liberation production was reduced to 330 tons daily. It is now planned to install further ovens in order to increase production to 1500 tons of coke daily and 440,000 cubic metres of gas.

Industrial and Labour Notes

Dividend Policy

Last week, Sir Archibald Forbes, president of the Federation of British Industries, addressed to the chairmen of all member-companies of the Federation a letter setting out the present views of the grand council on the subject of dividend policy. The letter refers to conversations between the F.B.I., the Chancellor of the Exchequer and the Minister of State for Economic Affairs, during which it was indicated that moderation and restraint in the distribution of profits would materially help in bringing the country's inflationary condition under control.

Sir Archibald's letter points out that the ultimate remedy must be found in increased production and increased productivity, and says also that—in the short term at least—there must be a reduction in internal spending. The letter goes on to say that more restraint has been exercised in the distribution of profits than in most other fields, and that the inflationary pressure which would directly result from an increase in dividends is negligible. Nevertheless, it is considered that there are strong grounds why industry should continue to act with moderation in this matter, especially as it is not now proposed to effect statutory control of dividends.

The letter adds that the F.B.I. has repeatedly stressed the concern now being felt in industry about the difficulty of keeping industrial capital intact in face of the burden of taxation and the need to provide out of profits for the replacement of assets at existing inflated prices. The need to conserve internal resources under such conditions is sufficiently apparent, but the letter suggests that much misunderstanding and misrepresentation concerning the level of industrial profits during an inflationary period would be avoided if the extent to which profit has to be applied for the purposes referred to was clearly brought out in published accounts. Furthermore, the letter says, it would be wrong to disregard the considerable psychological effect of any large and widespread increases in dividend distribution, which would be likely to stimulate further demands for increased remuneration and thus intensify inflationary pressure.

The Federation, Sir Archibald's letter concludes, fully recognises that a decision upon the amount of profits to be distributed by way of dividend is a matter for each board to determine in the light of all relevant circumstances. Its grand council, however, feels justified in urging that, in the present critical position of the country, the wider considerations of national and industrial interests should be carefully weighed in reaching such decisions, and is of the opinion that dividend policy for the time being should be characterised by moderation and restraint.

The Coal Situation

The higher output from the mines, which has become customary in the weeks preceding the Christmas holiday, has this year been more pronounced. In the week ended December 15th, coal production from the deep mines reached 4,708,000 tons, the highest output achieved in any single week since June, 1940. With 201,300 tons gained from opencast workings, the total output for the week was 4,909,300 tons, compared with 4,766,900 tons in the corresponding week of 1950. In the fifty completed weeks of this year up to December 15th, production from the deep mines amounted to 204,445,300 tons, or nearly 7,000,000 tons more than in the comparable period of last year, and from opencast workings 10,699,400 tons, which was more than 1,000,000 tons less than in the first fifty weeks of last year. This year's total output for the fifty completed weeks was, therefore, 215,144,700 tons, and it is thus reasonable to assume that the production figure of between 219,000,000 and 222,000,000 tons mentioned in this year's *Economic Survey* will be reached.

At the end of last week the National Coal Board issued its statistical statement on costs of production, proceeds and profits of collieries for the third quarter of this year. This is the quarter, of course, which is most affected by holidays. The total amount of coal disposable commercially during the quarter was 44,869,876 tons, and the total proceeds were £123,432,427. Production costs amounted to £119,845,924, so that profit during the quarter, before charging interest, was £3,586,503. The estimated profit of the Board's ancillaries was £550,000. Deductions from the quarter's total profits—which included £500,000 for miners' pensions and £230,000 representing the loss on imported coal—reduced the profit to £2,881,503. As the interest payable to the Minister of Fuel and Power required £3,750,000, there was a deficit for the quarter of £868,497.

Coal Miners' Wages

The Joint National Negotiating Committee of the Coal Industry, at a meeting on Wednesday of last week, confirmed the settlement of the wage claim put forward by the National Union of Mineworkers on October 10th. Most areas of the union have approved the settlement, which provides, in general, for an increase of 2s. 3d. a shift for adult underground workers and of 1s. 11d. a shift for surface workers. The national weekly minimum for adult underground workers is now £7 0s. 6d. and for adult surface workers £6 1s. 6d. The new rates apply from the first pay week after November 22nd.

A statement by the committee points out that, for the first time since the nationalisation of the coal-mining industry, a national increase—as distinct from local variations—has been given to pieceworkers. Consequently, the arrangements for the adjustment of piece rates at the pits are to be revised in order to limit variations to those rates that can be justified on the grounds of changed methods or conditions of working. A joint committee of the National Coal Board and the National Union of Mineworkers is to be set up to examine the whole procedure for regulating the wages and conditions of pieceworkers, and the present stabilisation of piece rates will operate for twelve months or until the joint committee has reached agreement on a revised procedure. This committee is to meet as soon as possible, as both sides are anxious for its deliberations to be concluded within the twelve months.

The Joint National Negotiating Committee's statement goes on to say that the Coal Board has agreed to the union's claim for a second week's holiday with pay. But in view of the current coal situation, and the output which would be lost if the extra holiday were taken in 1952, the miners are to forgo the second week next year and, instead, receive payment for it at the same rate as for the week they do take. The negotiating committee will consult the Divisional Coal Board and the union areas to determine the periods at which the additional payment shall be distributed. The existing voluntary overtime agreement continues until the end of April next, and the Coal Board and the union are to consider extending it to cover 1952–53.

Plant Maintenance Study in the U.S.A.

The Anglo-American Council on Productivity is arranging for a team of British specialists to visit the U.S.A. to study current practice in plant maintenance. Mr. J. B. Stevenson, works director of E.M.I. Factories, Ltd., will lead the team.

Arrangements have been made for visits to undertakings—mainly in the eastern part of the U.S.A.—engaged in mechanical, electrical and aeronautical engineering, and in the manufacture of food, textiles, steel, paper, and wood and oil products. The team intends to pay particular attention to what is known as "planned preventive maintenance," and will also examine such matters as wage structures and safety precautions instituted for the protection of maintenance staffs. The programme also includes a visit to the Plant Maintenance Conference and Show, which is to be held in Philadelphia in the middle of January.

British Overseas Trade

Following its announcement, last week, of the provisional trade figures for November, the Board of Trade has stated the value of United Kingdom exports for the month as £243,900,000. It says that in the first eleven months of this year exports have been at an annual rate of £2,592,000,000, or 19 per cent above the total for 1950. The Board of Trade has pointed out, however, that most of this increase is attributable to higher prices, and that the actual volume of exports has been about 4 per cent higher than last year. Exports to Canada and the U.S.A. in November were valued at £21,400,000, compared with £22,100,000 in October. The November figure was 9 per cent below the average for the first ten months of the year, but 7 per cent above the monthly average for 1950.

Giving details of November exports from the United Kingdom, the Board of Trade says that those of raw materials, valued at £8,200,000, were £700,000 higher than in October, although there was a drop in exports of coal. The total value of manufactured goods exported in November was £216,600,000, which was £7,500,000 higher than in October, and £22,800,000 above the average for the third quarter. In this latter group, machinery exports accounted for £35,500,000, a figure £2,400,000 higher than that for the preceding month. The most outstanding increase in November, however, was in the vehicles group, the value of car and commercial vehicle exports alone being £3,200,000 higher than in October. The number of cars and chassis sent overseas was 37,837, valued at £13,100,000, and was 17 per cent above the October total. This increase, it is explained, was due entirely to higher exports to Australia and New Zealand. In spite of the high number of cars and chassis—15,446—sent to those two countries in November, however, the total sent to them so far this year has been 11 per cent below the rate of export in 1950.

The value of imports in November was £328,200,000, which was the lowest monthly figure since April, and was only just above the average for the first ten months of this year. The Board of Trade says that the recently imposed import restrictions probably had little effect on recorded imports in November. Total imports this year, up to the end of November, were at an annual rate of £3,930,000,000, or 51 per cent above the 1950 average.

Raw Material Supply Prospects

The Ministry of Materials has recently surveyed the present overall position and prospects of raw materials supplies. It says that supplies generally have improved a good deal since the early part of the year, although, in many instances, the improvements have not been sufficient to meet the expanding industrial demand.

Dealing in particular with copper, the Ministry observes that the present shortage has arisen because the development of new sources of supply has been temporarily outstripped by the rising trend of consumption, stimulated by rearmament. In the last fifty years world consumption of copper has quintupled, and if it continued to rise at the same rate by 1975 it would exceed 5,000,000 tons a year, or about twice last year's consumption. The survey says, of course, that the actual rate of increase may slacken to some extent owing to substitution. Total reserves of copper are sufficient to last for many years; about one-quarter of them are within the Commonwealth, principally in Northern Rhodesia—which is our main source of supply—and Canada. Increased production of copper in Northern Rhodesia depends largely on the supplies of coal from Southern Rhodesia, and the transport problem is a difficult and complex one. The survey says that special efforts are being made to meet the situation by all practicable measures.

Notes and Memoranda

Rail and Road

A Cycle and Motor Cycle Exhibition in 1952.—The Council of the British Cycle and Motor Cycle Manufacturers' and Traders' Union announces that it has decided to hold a Cycle and Motor Cycle Show at Earls Court next year from November 15th to 22nd.

Diesel Locomotives Ordered for New Zealand.—We are informed by the Hunslet Engine Company, Ltd., that it has received an order from the New Zealand Government Railways for ten 30-ton, 3ft 6in gauge, six-wheel, 250 b.h.p., diesel mechanical locomotives for shunting and light train working. These locomotives, which will have a top speed of 25 m.p.h. and a starting tractive effort of 16,800 lb, will be fitted with roller-bearing axle-boxes and Westinghouse air brakes.

South London Tram Conversion Scheme.—On the night of January 5/6th next there will come into effect the sixth stage of the scheme for converting South London's tram routes to bus operation. This stage, the most extensive so far, consists of the replacement of six more tram routes by a similar number of bus routes. It will see the end of trams at Victoria and along Vauxhall Bridge Road as well as in Grove Park, Downham and Catford. With this conversion, 109 trams will be withdrawn from service on 13·6 route miles and replaced by 105 buses.

Specification for Road and Bridge Works.—Requirements for clearing, fencing and draining highways, for earthworks, culverts, walls, carriageways and other road works, and for single and multi-span bridges are contained in the Ministry of Transport's Specifications for Road and Bridge Works, which has recently been published. This document constitutes Part I of the Schedule to the Ministry of Transport's Standard Conditions of Contract for Road and Bridge Works, prepared for trunk roads. It is obtainable from H.M. Stationery Office, price 5s. Part II of the Schedule (Notes on the Preparation of the Bill of Quantities) is published as a separate document, price 2s. It is intended to illustrate the application and use of Part I.

Air and Water

Shipbuilding Centenary.—John Brown and Co., Ltd., of Clydebank, has completed a century of shipbuilding and at a dinner held to celebrate this attainment Lord Weir proposed the toast of "The Clydebank Shipyard: One Hundred Years of Shipbuilding."

New Cunard Liners.—It was announced last week by the Cunard Steamship Company, Ltd., that it had placed orders with John Brown and Co., Ltd., for the construction of two liners for the company's Canadian service. The ships will be each of about 20,000 tons gross and designed for a speed of 20 knots, and it is hoped that the ship will sail on her maiden voyage in 1954.

The "Lucy Ashton."—The former Clyde paddle steamer "Lucy Ashton," which has been used by the British Shipbuilding Research Association for the purpose of carrying out full-scale resistance experiments, is to be broken up. The jet engines, which were used for propulsion purposes, and the various recording instruments, have been removed, and the ship will be towed to Faslane for demolition by Metal Industries, Ltd.

The Up-River Collier "Croydon."—The motor collier "Croydon," which was built by the Burntisland Shipbuilding Company, Ltd., for the South-Eastern Gas Board, completed her trials earlier this month and arrived in the Thames last week on her maiden voyage from the Tyne. The vessel, which carried 3000 tons of coal, has a raised quarter deck with bridge and forecastle, and is specially designed with low superstructures and telescopic masts in order to pass under the seventeen bridges of the Thames to deliver coal to the upper reaches.

Aluminium in the Shipyard.—The Aluminium Development Association has recently published its information Bulletin No. 18: "The Working of Aluminium in the Shipyard." This bulletin contains practical information, based upon experimental work, which is helpful to shipyard managers, foremen and technical staffs. The various operations in working plate material are discussed, followed by notes on sheet metal work and general recommendations regarding the machining of the alloys. There is a section devoted to methods of joining and the latest information concerning rivet point shapes, cold and hot riveting and hole clearances is given, together with tables containing data related to pneumatic driving and squeeze driving. Welding techniques are touched upon, including gas and metallic arc, argonarc, spot and stud welding methods. The subject of contact with other materials is reviewed and brief note included upon painting, anti-fouling compositions and deck compositions. There are three appendices and they deal with the recommended alloys, including a note on Lloyd's requirements, the sizes of material available and a general reference to heat treatment. Copies may be obtained from the Association at 33, Grosvenor Street, London, W.1. Price 2s., post free.

Refit of Royal Liner.—The Shaw Savill liner "Gothic," which has been refitted and converted for the Royal tour to Australia and New Zealand by Cammell Laird and Co., Ltd., sailed for Southampton last week. The original lay-out of boat and promenade decks has been rearranged and the superstructure extended to accommodate their Royal Highnesses. Provision has also been made for the Flag Officer, Royal Yacht, Vice-Admiral C. E. Lambe, and for units of the Royal Navy and Royal Marines.

Miscellanea

Building Research Congress, 1951.—Books containing the papers presented in the three divisions of the Building Research Congress held last September may be obtained, price 22s. 6d. each or 50s. for the set of three, from the organising secretary, Building Research Congress, 1951, Building Research Station, Garston, Watford, Herts. The record of discussions which took place at the technical sessions of the congress may be ordered now in advance of publication.

Special Courses in Higher Technology.—The Regional Advisory Council for Higher Technological Education has issued its *Bulletin No.* 4 on special courses in higher technology, which will open in London and the Home Counties area in the spring of 1952. This *Bulletin* gives full details of these courses at some twenty-five university colleges, technical colleges and polytechnics. Copies of the publication can be obtained from the Council's offices at Tavistock House, Tavistock Square, London, W.C.1, at 1s. 6d. net.

Repair of Concrete and Timber Piles.—We have received from the Masonry Resurfacing and Construction Company, Inc., B. and O. Coal Pier, Baltimore, 26, Maryland, U.S.A., some information about a new system of repairing piles which have deteriorated between tide levels. The method, known as "Dri-Por," is intended primarily for concrete piles, but may also be used for wooden ones, and embodies a small caisson attached to the pile for carrying out the work; a steel shutter encasing the pile is left permanently in place, and the repair is completed with "gunite."

Steel Economy in Reinforced Concrete.—In view of the urgent need for economy in the use of steel, the council of the Reinforced Concrete Association has given renewed consideration to a suggestion that the working stress of 18,000 lb per square inch normally permitted in mild steel reinforcement complying with B.S. 785 might safely be increased and the quantity used in reinforced concrete structures thus reduced. Although no yield stress is specified in B.S. 785, recent tests indicate that the yield stress in mild steel bars of the smaller diameters is generally at least 36,000 lb per square inch. This being so, the council is satisfied that a working stress of 20,000 lb per square inch may safely be adopted in bars of $\frac{1}{2}$in diameter and less, except in the design of liquid-retaining and other special structures. Further consideration is being given to the question whether, and under what terms, a similar recommendation can be made in relation to mild steel bars of diameters greater than $\frac{1}{2}$in.

Release of Employees for Technical Study.—In its third annual report, the Regional Advisory Council for Higher Technological Education gives an interesting note on the release by employers of persons over the age of eighteen years for technical study. It states that representations have been made to the National Advisory Council, the Ministry of Education and the Ministry of Labour and National Service, in an endeavour to bring about a general request to industry to include in apprenticeship agreements specific arrangements to extend periods of study during working hours beyond the age of eighteen. These arrangements would include limitations similar to those agreed between the Engineering and Allied Employers' National Federation and the manual workers' unions affiliated to the Confederation of Shipbuilding and Engineering Unions. Up to the present, it is stated, the national bodies approached have been unwilling to comply with the suggestion. The council proposes to continue to press with the matter.

Local Government Manpower Committee Report.—The second report has now been issued by the committee set up in 1949 to examine the use of manpower by local authorities in England and Wales. The first report of the committee was published in December, 1949. In its early work the committee concentrated mainly upon the possibility of relaxing departmental supervision of local authority activities and delegating more responsibility to local authorities; and it recommended revised arrangements over a wide field. Its later work was mainly concerned with reviewing and co-ordinating existing arrangements for ensuring economy in the use of manpower by local authorities and those Government departments concerned with local government matters.

Centenary of Negretti and Zambra, Ltd.—To mark the completion of 100 years' service in industry, Negretti and Zambra, Ltd., has published an interesting brochure giving some particulars of its history and the development of its products. The firm was founded in 1850 by Henry Negretti and J. W. Zambra for the manufacture of meteorological instruments in premises in Hatton Garden. The partnership between the two families through succeeding generations continued until June, 1946, when for family reasons the business was converted into a private company and into a public company in 1948. The book tells how towards the end of the nineteenth century the firm began to make a range of optical instruments and about the same time introduced a number of improvements in its meteorological instruments. It then describes how, during subsequent years, there were developed the many types of gauges and recording instruments for which the company is now so well known. As the number of the firm's products increased, so its works premises were extended, and the firm recently acquired a factory of 50,000 square feet at Aylesbury, with room for future expansion, where in the distant future all of its production will be concentrated.

Personal and Business

Mr. David Higgs, B.Sc., has been appointed a director of Higgs Motors, Ltd., Witton, Birmingham.

Mr. J. M. Palmer has been appointed sales manager of Mackay Industrial Equipment, Ltd., Faggs Road, Feltham, Middlesex.

The Institute of Packaging has moved to 20–21, Took's Court, Cursitor Street, London, E.C.4. (Telephone, Chancery 8484.)

Mr. P. Butler, B.Sc., M.I.E.E., and Mr. W. B. Laing, M.I.E.E., have been appointed joint general managers of Bruce Peebles and Co., Ltd., Edinburgh.

Mr. Kenneth Gordon, C.B.E., M.C., has been appointed deputy managing director of Head Wrightson Processes, Ltd., Teesdale House, 24–26, Baltic Street, London, E.C.1.

Bruce Peebles and Co., Ltd., Edinburgh, states that its works will close for the New Year holiday on Monday evening, December 31st, and will reopen on Friday morning, January 4th.

Mr. C. Jackson, M.I.Struct.E., has been appointed resident director in Australia for S. S. Lynn, Ltd., Birmingham. Mr. Jackson's address will be 243, Elizabeth Street, Sydney, N.S.W.

R. H. Windsor, Ltd., Royal London House, 16, Finsbury Square, London, E.C.2, announces an arrangement with F. J. Stokes Machine Company, Philadelphia, whereby the latter company will handle Windsor plastics machines in the U.S.A.

E. Boydell and Co., Ltd., Old Trafford, Manchester, states that Mr. C. L. Cookes has been appointed area representative in the Midlands and South Wales. He will operate from the company's depot at New Wolverhampton Road, Langley, Birmingham.

The British Aluminium Company, Ltd., announces the retirement of Mr. W. H. Platt, assistant sales manager (wrought products) after forty-one years' service in the company's sales division. Mr. C. F. Batstone, principal assistant sales manager is taking over the duties formerly carried out by Mr. Platt.

Mr. L. W. Cole, B.Com., has been appointed secretary of Babcock and Wilcox, Ltd., in succession to Mr. H. B. Clark. He has been assistant secretary since 1943. Mr. Clark, who is retiring at his own request, will continue to serve as a director of some of the firm's subsidiaries, including Dewrance and Co., Ltd., Bailey Meters and Controls, Ltd., Spencer Bonecourt, Ltd., and the Clarkson Thimble Tube Boiler Co., Ltd.

British Patent Specifications

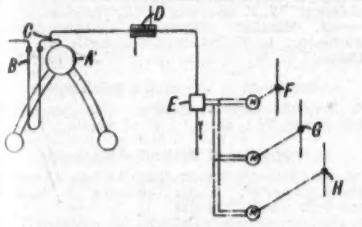
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

STEAM GENERATORS

662,082. May 4, 1949.—Steam-Raising Plant and Steam Power Plants, Leonard Baker, "Chestnuts," Blakeley Road, Raby Mere, Wirral, Chester.

The invention relates to steam-raising plant and to steam power plants, and is applicable especially to superheated steam boiler and turbine plants in which excess of water content in the steam leaving the boiler drum or excess of solid content in



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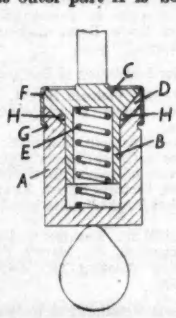
the water passing over with the steam may cause damage to the plant; the object of the invention is to safeguard the plant against damage. In steam power plants operating at very high pressures, say, 1200 lb per square inch and above, the invention affords a direct indication of the solid content of the steam and a direct safeguard against excess solid content. As shown in the drawing, a water-tube boiler *A* has a superheater *B* in which a steam sample is continuously bled from a point *C* between the steam drum and the superheater. A pipe leads from the point *C* to a condenser *D* which discharges through a pipe to a unit *E* which embodies a testing device and an electrical relay or energising amplifier, from which the condensate is discharged through a pipe. The relay or the amplifier *E* controls electric motors *M*, adapted respectively to operate control valves *F*, *G*, *H* of the power plant which may, for example, respectively control the oil fuel supply, the feed water supply to the boiler, and the steam discharge from the boiler. The valves may be operated selectively as different electrical conductivities are measured by the testing device of the unit *E*.—*November* 28, 1951.

INTERNAL COMBUSTION ENGINES

662,501. July 18, 1949.—Tappets, William Alexander Scott, "Treetops," Birmingham Road, Shenstone, Stafford.

The object of the invention is to enable variations in the length of the tappet due to temperature variations and other causes to be automatically compensated. As shown in the drawing, there are a pair of hollow cylindrical telescopic parts *A* and *B*. One end of the outer part *A* is bevelled inwards



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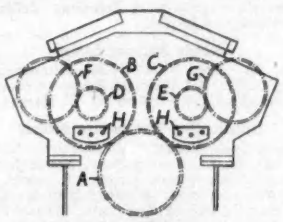
at an angle of about 45 deg. The adjacent end of the other part is formed with a head *C*, the underside of which is also bevelled, but at a different angle, so that the bevelled surfaces form between them a narrow, but tapering, annular groove *D* of truncated conical form, the narrowest part of the groove being at its inner end. Within the two parts a spring *E* imparts relative axial movement in the direction for increasing the width of the groove. The extent of this movement is limited by an outer retaining ring *F* which at one end engages a circumferential groove *G*. Within the groove *D* are several small steel balls *H*, which tend to gravitate towards the smaller end of the groove, and serve as the required wedging means. The action of the tappet is as follows: the force exerted by the cam is transmitted through the balls to the upper part of the tappet which abuts against the valve stem. After the completion of the opening of the valve the load is momentarily released from the balls, which are freed to move outwards due to momentum and vibration. This movement reduces the overall length of the tappet to the minimum, and the tappet remains in this condition whilst the valve is closing. When the valve contacts its seat the tappet spring separates the two telescopic parts and the balls move inwards and wedge the parts in position for repeating the cycle. So long as the overall length of the mechanism remains unchanged, the balls always return to the same position, but when, through temperature changes or other causes, such as slight wear or strain, the initial length of the operating mechanism changes, the position of rest of the balls will also change so that the initial overall length of the operating mechanism is automatically maintained.—*December* 5, 1951.

662,143. January 4, 1949.—Construction of Internal Combustion Engines, Davey Paxman and Co., Ltd., Standard Ironworks, Colchester, Essex (*Inventor: Edward Philip Paxman*).

This invention relates to internal combustion engines with the cylinders arranged in two banks of V-formation, the object being to provide an improved balancing means applicable to engines having an odd number of cylinders in each bank. Referring to the drawing, *A* represents a gear



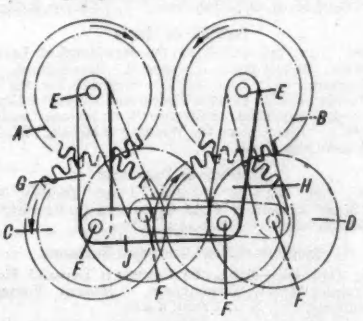
No. 662,143

wheel carried by one end of the engine crankshaft, and *B* and *C* are gear wheels meshed with it and driven at crankshaft speed. Mounted coaxially with the gear wheels *B* and *C* respectively, and rotating with them, are gear wheels *D* and *E*, which, by meshing with timing camshaft gear wheels *F* and *G* respectively, transmit the drive from the crankshaft to the timing camshaft of each cylinder bank. The shafts of the gear wheels *B* and *C* extend along the engine and carry, at or near their ends and adjacent the ends of the crankshaft, balance weights *H* which, when the engine is in operation, rotate to set up a couple to neutralise the natural unbalance couple of the engine. These balance weights, by reason of their relative phase relationship, are statically balanced or their respective shafts. An alternative to the arrangements described is also described in the specification.—*December* 5, 1951.

POWER TRANSMISSION

662,056. January 24, 1949.—Gearing for Conveying Rotary Motion, Timsons, Ltd., Perfecta Works, Kettering, Northamptonshire, and Ernest Arthur Timson, of the Company's address.

This invention is intended to provide improvements in gearing designed to enable relative circumferential motion of desired gears in a set or group to be varied without interruption



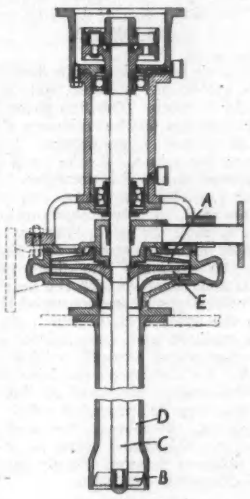
No. 662,056

of the drive. As shown in the drawing, there is a pair of non-meshing gears *A* and *B* spaced apart in a common plane, and a pair of meshed gears *C* and *D*. The gear *A* is in mesh with the gear *C*, whilst the gear *B* is similarly arranged in mesh with the gear *D*. The pairs of spur gears are provided with laterally extending central pivots *E* and *F*, upon which are freely pivoted the ends of straight links *G*, *H* and *J*. The two links are of the same length and extend from the pivots *E* of the two spaced non-meshing gears to the pivots *F* of the meshed gears and these pivots are connected by a further link *J*, the three links together providing an open-sided link frame capable of being swung in either direction about the fixed axes of the spaced gears. The two links *G* and *H* connecting the spaced and the meshed gears extend parallel or substantially so to each other, this parallelism being maintained during swinging movements of the link frame—like a parallel ruler motion. As shown, the spaced non-meshing gears normally rotate in opposite directions.—*November* 28, 1951.

PUMPS

662,614. October 15, 1949.—Centrifugal Pumps, Paul Bungartz, 87, Leostrasse, Düsseldorf-Oberkassel, Germany.

In the drawing it will be seen that above the liquid surface, which may be a corrosive liquid, there is arranged a normal centrifugal pump with an auxiliary impeller *A* for the sealing of the shaft joint. A priming impeller *B* dipping in the liquid is attached to a shaft *C* in a suction tube *D*. When



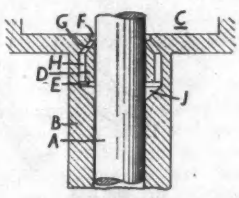
No. 662,614

the pump is running the priming impeller draws the supply liquid so far up that it becomes entrained by the main impeller *E*. Only the shaft, the suction tube and the priming impeller are in continual contact with the corrosive fluid to be pumped. With a small shaft diameter and a light priming impeller large depths of immersion are attainable.—*December* 5, 1951.

MISCELLANEOUS

662,405. October 27, 1949.—Devices for Carrying Off Lubricant, N.V. Philips, Gloeilampenfabrieken, Emmasingel 29, Eindhoven, Holland.

This invention relates to a device for carrying off lubricant removed by a scraping member formed on a body, from the surface of a relatively reciprocating body. As shown in the drawing, a piston-rod *A* reciprocates in a bush having cylindrical parts *B* and *D*. The portion *D* has a trapezoidal cross



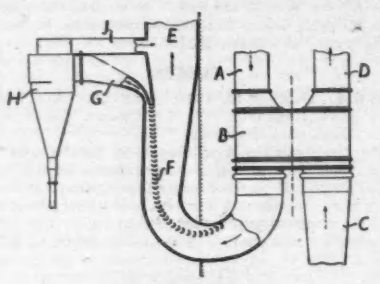
No. 662,405

section, the surface *E* of which provides a scraping edge by which a quantity of lubricant is scraped from the piston-rod so that on entering the work space *C* the piston-rod carries a comparatively thin layer of lubricant. During the backward stroke the removal of lubricant by the bore *F* of the cylinder end plate is prevented by making it of larger diameter than the piston-rod. Another scraping edge *G* removes lubricant during the backward stroke, and the lubricant flows through the

channel system *H* to the space *J* adjoining the scraping edge *E*. It is found that with this arrangement the level of lubricant remains substantially constant in the space *J*, and the average consumption of lubricant is very small. A modified construction is also shown in the specification.—*December* 5, 1951.

662,072. March 18, 1949.—APPARATUS FOR SEPARATING DUST FROM GASES, The Koninklijke Machinefabriek Gebr. Stork and Co., N.V., Haaksbergerstraat 11, Hengelo (O), The Netherlands.

As shown in the drawing, dust-laden flue gases are discharged from a boiler plant by a duct *A* connected to a rotary regenerative air heater *B*,



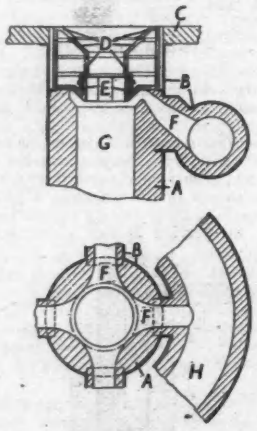
No. 662,072.

to which the air is supplied by a duct *C* and from which the heated air is discharged by a duct *D* to the boiler furnace. The flue gases leaving the air heater pass up to the chimney *E* through a bend which forms a passageway having inner and outer wall portions. In the bend a grid composed of curved blades *F* is arranged. In the bend the coarser particles are thrown out of the gases against the wall by centrifugal action, so that they do not reach the grid. The gases ascend in the channels formed between the blades of the grid; in the channels the finer particles are thrown out and, together with the coarser particles and part of the gases, are conveyed through conduit *G* to the cyclone *H*, in which the solid particles are retained and from which the cleaned gases are discharged through conduit *J* into the chimney *E*. As the coarser particles do not reach the grid, the wear is restricted to the wall of the bend which can be provided with replaceable wearing plates. Moreover, the dust separating plant need no additional space as the bend is generally required between the air heater and the chimney.—*November* 28, 1951.

FURNACES

662,325. December 6, 1949.—CUPOLA FURNACES, Georg Fischer Aktiengesellschaft, Schaffhausen, Switzerland.

This invention relates to a cupola furnace and includes a blast heater for preheating the blast by means of the furnace gases. As the drawings show, the masonry *A* of the cupola furnace has a metal



No. 662,325

jacket *B* and a throat plate *C*. The narrower upper portion of the charging shaft *D* is constructed of shaped iron bricks. As the lower portion of this shaft is subjected to considerable scale formation, segmental bricks *E* of highly refractory material which can readily be exchanged are provided. Four off-takes *F* for the withdrawal of the blast-furnace gas lead from the widened diameter *G* of the shaft into an annular main *H*, from which the waste gases are passed by means of an exhauster through the blast heater or regenerator into the atmosphere. When the exhauster of the blast heater is inoperative, the furnace gases are discharged, as in normal cold-blast cupola furnaces, directly through the charging shaft *D*. As the exhauster is brought into operation, or the output increased, some or all of the furnace gases flow through the off-takes *F* into the blast heater. The off-takes are disposed at such a level in the cupola furnace shaft that no secondary air is sucked from the charging shaft and no premature combustion of the furnace gases occurs. The exhauster is designed to withdraw 80, 90 or 100 per cent of the furnace gases according to requirements for the melting outputs. The utilisation of the furnace gases in the blast heater is complete when no more furnace gases can be detected in the charge.—*December* 5, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Cleveland Institution of Engineers

Mon., Jan. 7th.—Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Recent Developments in American Rolling Mills," R. Stewartson, 6.30 p.m.

Electric Railway Society

Sat., Jan. 5th.—Fred Tallant Hall, Drummond Street, London, N.W.1, "A Pictorial Survey of Electric Railways in Holland and Belgium" G. W. Morant, 3 p.m.

Illuminating Engineering Society

Thurs., Jan. 3rd.—NOTTINGHAM CENTRE: E. Midlands Electricity Board, Smithy Row, Nottingham. "The Lighting of Modern Ocean Liners," T. Catten, 5.30 p.m.

Fri., Jan. 4th.—BATH AND BRISTOL CENTRE: S.W. Electricity Board, Old Bridge, Bath, "Neon Lighting." C. Higgins, 7 p.m.——BIRMINGHAM CENTRE: Imperial Hotel, Temple Street, Birmingham, "Modern Transport Lighting," W. E. J. Drake, 6 p.m.——HUDDERSFIELD GROUP: Electricity Showroom, Market Street, Huddersfield, "The Use and Misuse of Fluorescent Lighting," T. C. Holdsworth, 7.15 p.m.

Incorporated Plant Engineers

Tues., Jan. 1st.—Institute of Engineers, Park Place, Cardiff, "Hard Surfacing with Stellite," 7.15 p.m.

Wed., Jan. 2nd.—SOUTHAMPTON BRANCH: Polygon Hotel, Southampton, Talk on the Application of the Factories Act, 7.30 p.m.

Thurs., Jan. 3rd.—PETERBOROUGH BRANCH: Eastern Gas Boards Demonstration Theatre, Church Street, Peterborough, "Power Distribution," G. J. Richardson, 7.30 p.m.

Tues., Jan. 8th.—E. LANCS BRANCH: Engineers' Club, Albert Square, Manchester, "Secondary Air and its Application," H. Hetherington, 7.15 p.m.——EDINBURGH BRANCH: 25, Charlotte Square, Edinburgh, "Organisation of Scientific Research in Great Britain," H. Buckley, 7 p.m.

Institute of British Foundrymen

Sat., Jan. 5th.—BIRMINGHAM AND W. MIDLANDS STUDENTS' SECTION: Works visit to Round Oak Steel Works, Ltd., Brierley Hill, Staffs, 10 a.m.

Mon., Jan. 7th.—SHEFFIELD BRANCH: College of Technology, Pond Street, Sheffield, 1, "Synthetic Resins as Foundry Sand Binders," P. G. Pentz, 7.30 p.m.

Tues., Jan. 8th.—BURNLEY SECTION: Grammar School, Blackburn Road, Accrington, "Phosphor Bronze," E. Jackson, 7.30 p.m.

Institute of Marine Engineers

Tues., Jan. 8th.—85, The Minories, London, E.C.3, "Diesel-Hydraulic Propulsion," F. J. Mayor, 5.30 p.m.

Institute of Metals

Thurs., Jan. 3rd.—Visit to the Metallurgical Laboratories, Birmingham University, Birmingham, 15, discussion on "Tool and Die Materials for the Hot Working of Non-Ferrous Metals and Alloys," 2.30 p.m.——LONDON LOCAL SECTION: 4, Grosvenor Gardens, S.W.1, "Research on the Working of Metals," W. C. F. Hessenberg, 7 p.m.

Institute of Petroleum

Wed., Jan. 9th.—26, Portland Place, London, W.1, "Some Aspects of Field Operations in Kuwait," E. Boaden and E. C. Masterson, 5.30 p.m.

Institute of Road Transport Engineers

Fri., Jan. 4th.—MIDLANDS CENTRE: Imperial Hotel, Temple Street, Birmingham, "Modern Transport Lighting," W. E. J. Drake, 6 p.m.

Tues., Jan. 8th.—WESTERN GROUP: Visit to the Works of Bristol Tramways and Carriage Co., 2.15 p.m.; Grand Hotel, Bristol, "The Servicing of Buses," J. W. Kinchin, 7.30 p.m.——EASTERN GROUP: Royal George Hotel, Colchester Road, Ipswich, "The Development of the High-Speed Diesel Engine," S. Johnson, 7 p.m.

Institution of Civil Engineers

Tues., Jan. 1st.—Great George Street, Westminster, London, S.W.1, "Some Problems in the Disposal of Industrial Effluents and Domestic Wastes," J. T. Calvert and P. M. Amcotts, 5.30 p.m.

Tues., Jan. 8th.—Great George Street, Westminster, London, S.W.1, "The Organisation of Airport Construction," Patrick Hogan, 5.30 p.m.

Institution of Electrical Engineers

Mon., Jan. 7th.—S. MIDLANDS CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Protection of Electrical Power Stations: A Critical Review of Present-Day Practice and Recent Progress," H. Leyburn and C. H. W. Lackey, 6 p.m.

Tues., Jan. 8th.—MEASUREMENTS AND RADIO SECTIONS: Savoy Place, London, W.C.2, "Two Electronic Resistance or Conductance Meters," L. B. Turner; "A Bridge for the Measurement of the Dielectric Constants of Gases," W. F. Lovering and L. Wiltshire, 5.30 p.m.——N. MIDLAND CENTRE: British Electricity Authority, 1, Whitehall Road, Leeds, 1, "Crystal Diodes," R. W. Douglas and E. J. James, 6.30 p.m.

Institution of Industrial Administration

Fri., Jan. 4th.—LONDON CENTRE: Management House, Hill Street, W.1, annual general meeting, 7 p.m.

Institution of Mechanical Engineers

Tues., Jan. 1st.—COVENTRY A.D. CENTRE: Craven Arms Hotel, Coventry, "Shock Absorbers," J. W. Kinchin and C. R. Stock, 7.15 p.m.

Fri., Jan. 4th.—Storey's Gate, St. James's Park, London, S.W.1, "Some Considerations on Bogie Design, with Particular Reference to Electric Railways," W. S. Graff-Baker, 5.30 p.m.——N.E. BRANCH, GRADUATES' SECTION: Northern Gas Board Showrooms, Grainger Street, Newcastle upon Tyne, "Modern Large Turbo-Alternator Construction and Erection," W. G. Bryce.

Mon., Jan. 7th.—N.E. BRANCH: Neville Hall, Westgate Road, Newcastle upon Tyne, "The Measurement and Interpretation of Machinery Noise, with Special Reference to Oil Engines," C. H. Bradbury, 6 p.m.

Tues., Jan. 8th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, London, S.W.1, "Stability of Single-Track Vehicles," R. A. Wilson-Jones, 5.30 p.m.——S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, annual meeting, "Some Fuel and Power Projects," H. Roxbee Cox, 6 p.m.

Institution of Production Engineers

Tues., Jan. 1st.—READING SECTION: Great Western Hotel, Reading, "Industrial Design and the Engineer," K. L. Brookfield, 7.15 p.m.

Wed., Jan. 2nd.—NOTTINGHAM SECTION: Welbeck Hotel, Milton Street, Nottingham, "Cost Control in Engineering," L. W. Robson, 7.15 p.m.——WOLVERHAMPTON SECTION: Star and Garter Hotel, Wolverhampton, "Polished Plate Glass and 'Armourplate' Glass," film, Mr. Hatton, 7 p.m.

Thurs., Jan. 3rd.—LONDON SECTION: Old Ship Hotel, Brighton, "Improvements and Their Hindrances," C. R. Whitaker, 7 p.m.

Mon., Jan. 7th.—HALIFAX SENIOR AND GRADUATE SECTION: George Hotel, Huddersfield, "Steam Turbine Manufacture," A. C. Annis, 7.15 p.m.

Tues., Jan. 8th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Vitreous Enamelling," S. Hallsworth, 7 p.m.——DUNDEE SECTION: Mathers Hotel, Whitehall Crescent, Dundee, "Production Engineering in Textiles," G. A. D. Coghlan, 7.45 p.m.

Institution of Structural Engineers

Mon., Dec. 31st.—MIDLAND COUNTIES' BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Films, "Buildings of the South Bank Exhibition," "Prelude to Power: The Building of the Castelo Do Bode Dam, Lisbon," "H.M.S.O., Sighthill, Edinburgh," 7 p.m.

Junior Institution of Engineers

To-day, Dec. 28th.—39, Victoria Street, London, S.W.1, "Hydro-Electric Power Developments," J. Foster Petree, 6.30 p.m.

Wed., Jan. 2nd.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Manufacture of Coins," G. H. Thompson, 7 p.m.

Fri., Jan. 4th.—39, Victoria Street, London, S.W.1, film evening, "Rocket Flight," introduced by S. G. Clark, 6.30 p.m.

Mon., Jan. 7th.—N.W. SECTION: Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester, ordinary meeting, A. Eaton, chairman's address, 7.30 p.m.

Leeds Metallurgical Society

Thurs., Jan. 3rd.—The University, Leeds, "The Platinum Metals, their Properties and Uses," J. C. Chaston, 7 p.m.

Liverpool Engineering Society

Mon., Jan. 7th.—Royal Institution, Colquitt Street, Liverpool, "Modern Developments in Electric Welding," H. G. Taylor, 6.30 p.m.

END OF VOL. CXCII

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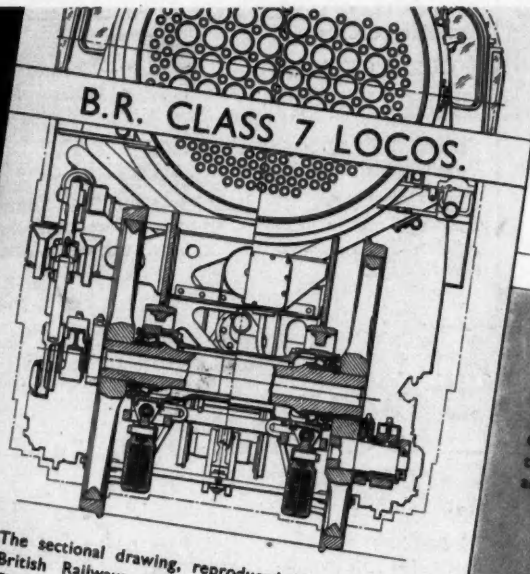
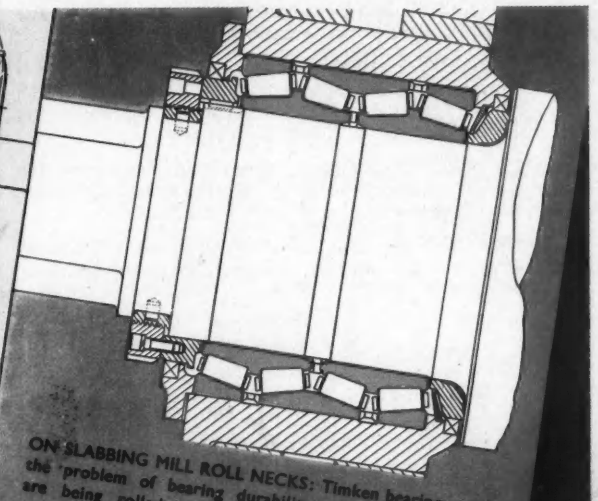
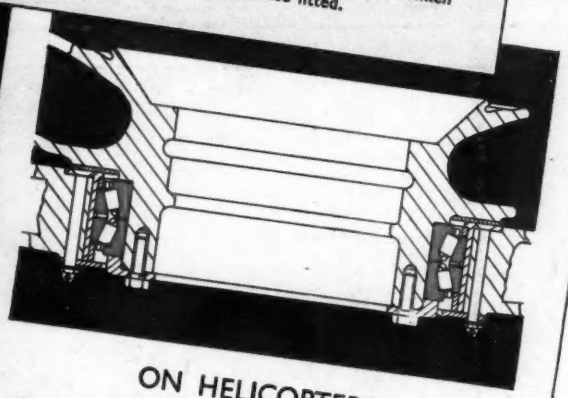


The sectional drawing, reproduced by courtesy of British Railways and 'The Engineer', show the Timken cannon box on the main driving axle; Timken axle-boxes are also fitted.

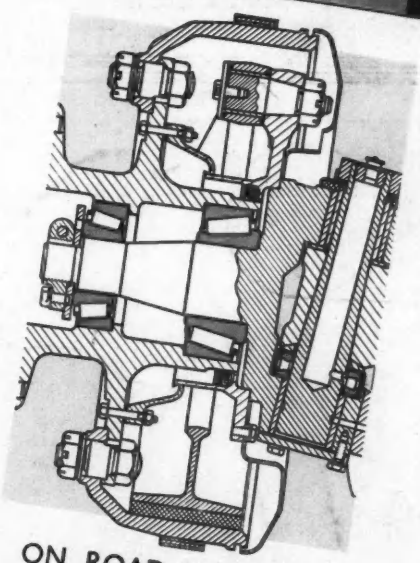


ON SLABBING MILL ROLL NECKS: Timken bearings solve the problem of bearing durability when high tonnages are being rolled. The illustration shows part of an installation for an important new steelworks.



ON HELICOPTERS

Timken tapered-roller bearings, with their great capacity for thrust and radial loads are especially valuable in helicopters. The line drawing shows Timken light-weight pre-adjusted bearings on the pitch change mechanism of one of the Westland designs.

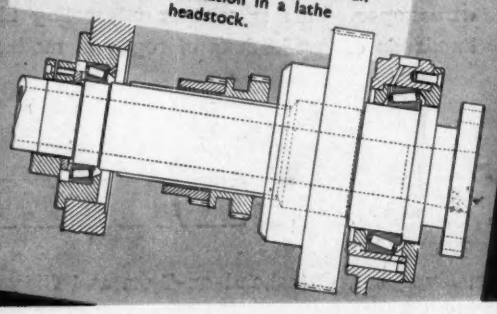


ON ROAD VEHICLES

Timken bearings are the accepted standard in the majority of high-duty situations: the drawing showing the front wheel bearings and king-pin thrust race on Leyland chassis.

ON MACHINE TOOLS

Timken bearings permit higher speeds, often with greater accuracy of the finished product: the drawing shows an effective installation in a lathe headstock.



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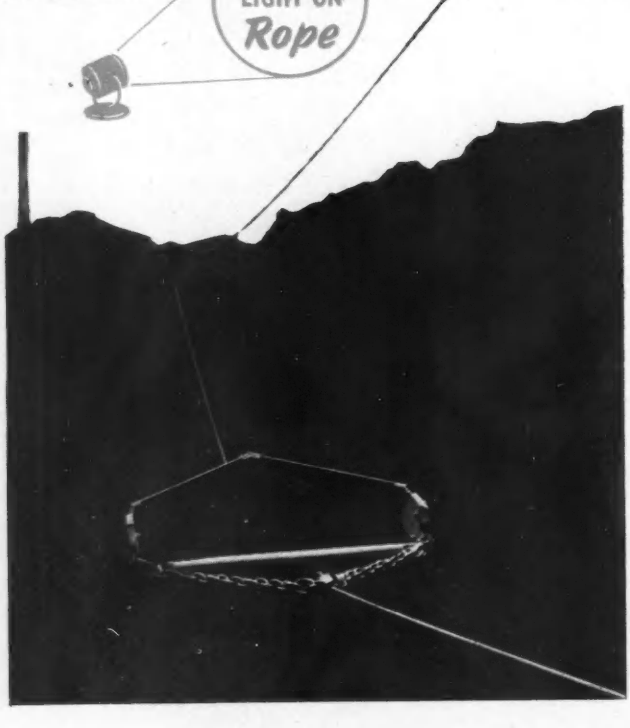

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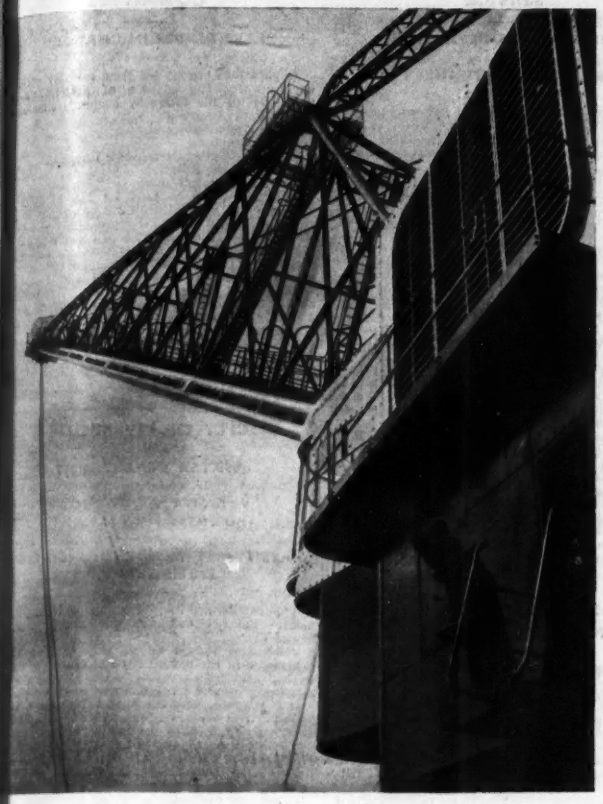


...b and rear end of 282 ft. jib. The "Visco" Rotating Self-Cleaning ...ters with oil spray cleaning device are behind the louvres at the top.

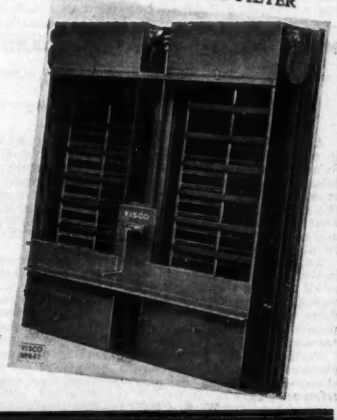
VISCO *Air Filters*

...n World's Largest Excavator

...les Verne never imaged anything quite so fantastic as "Walter", the Walking Dragline which Messrs. Ransomes & ...apier have built for Messrs. Stewart & Lloyds for use at the ...ronstone Quarries, Corby, Northants. Some idea of the vast ...ze of this 1,600 ton behemoth can be envisaged from the fact ...at it occupies an area equal to that of a football field.

Opencast mining in dry weather is dusty work, and to ensure ...ust-free air to the 14 electric ...otors and the cab, 2 "Visco" ...otating Self-Cleaning Filters of a ...otal capacity of 60,000 c.f.m. have ...een embodied in the Air Conditioning system.

STANDARD "VISCO" ROTATING SELF-CLEANING FILTER



...onsult us on all matters of Air Filtration ...nd Air Conditioning. Ask for list No. 465.

VISCO
ENGINEERING CO LTD
STAFFORD ROAD, CROYDON

Phones: Croydon 4181/4
Grams: Curtmit, Croydon

The Engineer

ESTABLISHED 1856

Vol. CXCII No. 5004

DECEMBER 21, 1951

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

SUBSCRIPTIONS

U.K. & ABROAD £5. 10. 0. CANADA £5. 5. 0. annually including postage. Every subscriber is entitled to one FREE copy of the DIRECTORY & BUYERS GUIDE as published—extra copies 2s. 6d. each post free.

CLASSIFIED ADVERTISEMENTS

LINEAGE RATE (Under 1 inch):—2s. 6d. per line of 6 words. Minimum 10s.

INCH RATE (1 inch and over):—Rates per insertion per single column inch—1 insertion—30s. 6 insertions—27s. 13 insertions—26s. 26 insertions—25s.

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WORDING OF ADVERTISEMENTS: Approximately the first 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC NOTICES

CITY OF LIVERPOOL—EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY BYROM STREET, LIVERPOOL, 3

Principal: R. B. BUTLER, M.Sc., F.R.I.C., F.C.S., F.I.I.A.

TEACHER (FULL-TIME) IN THE DEPARTMENTS OF CIVIL, MECHANICAL AND MARINE ENGINEERING

Applications are invited for the appointment of TEACHER (FULL-TIME) in the Departments of Civil, Mechanical and Marine Engineering.

Salary: Burnham Technical Scale, Grade B, Assistant, less 5 per cent. contribution under the Teachers' (superannuation) Acts. Industrial experience and service with H.M. Forces will qualify for a number of increments on the basic salary scale, which is £490 by £25 to £725, together with approved study or training allowance.

Applicants should possess good graduate qualifications or the equivalent, together with a First Class B.O.T. or M.O.T. Marine Engineer's Certificate of Competency. Some experience in electrical engineering is desirable.

Application forms and conditions of appointment may be obtained from H. S. Magnay, M.A., Director of Education, 14, Sir Thomas Street, Liverpool, 1, to whom completed forms should be returned not later than 5th January, 1952.

THOMAS ALKER,
Town Clerk and Clerk to the Local Education Authority (J.A. 2779) E6827

COUNTY COUNCIL OF THE COUNTY OF LANARK

EDUCATION COMMITTEE

LECTURER IN METALLURGY

Applications are invited from suitably qualified and experienced men for the post of LECTURER in METALLURGY at the Technical College, Coatbridge. This post necessitates the teaching of metallurgy up to and including the Higher National Certificate level. The successful candidate will also be expected to teach chemistry to the S1 and S2 level.

The basic salary payable will be as follows:—

(1) If a certificated teacher, in accordance with the Teachers' Salaries (Scotland) Regulations, 1951.

(2) If an uncertificated teacher:

(a) Honours Graduate (1st or 2nd Class) on a scale £535 to £875.

(b) Holder of the A.R.T.C. on a scale £535 to £800.

(c) Ordinary Graduate on a scale £435 to £725.

An additional payment will be made in respect of day hours of timetable duties in excess of 30 per week, and in respect of day timetable duties after the completion of 41 weeks in any session. Details of these payments, which may range up to £150 per annum, will be furnished on request.

Applications, with testimonials, to be lodged not later than two weeks after the appearance of this advertisement with the undersigned, from whom forms of application may be obtained.

JOHN S. McEWAN,
Director of Education.

Lanarkshire House,
191, Ingram Street,
Glasgow, C.1. E6820

OLDHAM EDUCATION COMMITTEE

MUNICIPAL TECHNICAL COLLEGE

Principal: E. M. STODDART, B.Sc., Ph.D. (London), Ph.D. (Dunelm), F.R.I.C.

FULL-TIME ASSISTANT

Applications are invited for the post of FULL-TIME ASSISTANT in the Department of Mechanical Engineering.

Candidates will be required to teach National Certificate subjects, including mathematics up to at least the third-year course, together with subjects in one or more of the following groups:—City and Guilds machine shop engineering, administration subjects, motor vehicle technology. The post is vacant on 1st January, 1952, and teachers with degree or equivalent qualifications, industrial experience, together with good day or evening practice in teaching, are invited to apply. The salary for the post is Grade A of the 1951 Burnham Further Education Report, i.e., within the range £375 to £720 per annum, according to experience and qualifications. Forms of application may be obtained from the undersigned, to whom they should be returned within two weeks of the appearance of this advertisement.

MAURICE HARRISON,
Director of Education.

Education Offices,
Union Street West,
Oldham. E6880

WOLVERHAMPTON CORPORATION WATER UNDERTAKING

DEPUTY SUPERINTENDENT

Wolverhampton Corporation Water Undertaking requires DEPUTY SUPERINTENDENT of Tettenhall Pumping Station and Reservoirs. N.J.C. Service Conditions: salary £440-£15-£485 (A.P.T. I); house to rent. Post pensionable; medical examination.—Application forms, returnable by December 31st, 1951, and details of duties from Water Engineer and Manager, Town Hall, Wolverhampton. E6731

PUBLIC NOTICES

SURREY COUNTY COUNCIL

EDUCATION COMMITTEE

RICHMOND TECHNICAL INSTITUTE, KEW ROAD, RICHMOND

ASSISTANT TEACHER

Applications are invited for full-time appointment as ASSISTANT TEACHER, Grade A, to take technical drawing and mathematics to part-time day release students. Ability to help with engineering science would be an added qualification. Drawing-office experience essential and teaching experience preferable. Outside interests should be stated. Salary, £375 by £18 to £630, plus £36 or £48 per annum, while serving in the London area. Commencing salary depends on previous teaching and war service. Increments may also be given for approved industrial experience.

Further particulars and application forms are obtainable from the Principal, to whom they should be returned within fourteen days of the appearance of this advertisement. E6826

EASTERN GAS BOARD

TOTTENHAM DIVISION

POWER ENGINEER—WILLOUGHBY LANE WORKS

Applications are invited for the following appointments:—

POWER ENGINEER—WILLOUGHBY LANE WORKS

Candidates should be Corporate Members of the Institution of Electrical Engineers or hold an equivalent qualification.

The duties will mainly comprise:—

(a) Technical supervision of operation of steam and electric power plant.

(b) Supervision of electrical installation work, maintenance of electrical plant, including supervision of craftsmen.

Residence, adjoining the works, will be available in this case at a reasonable rental.

MECHANICAL ENGINEER—DIVISIONAL OFFICE

Candidates should be Corporate Members of the Institution of Mechanical Engineers or hold an equivalent qualification.

The responsibilities cover the eight gasworks of the Division and the duties will mainly comprise:—

(a) Supervision of all mechanical requirements under the Factories Acts, e.g., steam boilers and pressure vessels, gasholders, lifting appliances, &c.

(b) Safety precautions.

(c) Inspection of mechanical plant at makers' works and supervision of erection.

(The works engineers in each locality are responsible for mechanical maintenance.)

MECHANICAL ASSISTANT—PONDERS END WORKS

Candidates should be Corporate Members of the Institution of Mechanical Engineers or hold an equivalent qualification.

The candidate appointed will be one of the two main technical assistants of the works engineer, the other being the production assistant. He will be responsible for mechanical and structural maintenance and must be capable of organising this work on a planned basis.

Candidates should have experience in steam and diesel plant and in the supervision of craftsmen.

Candidates for all the above posts should be between 27 and 45 years of age. The successful candidates will be required to pass a medical examination and to join such contributory superannuation scheme as the Board may adopt.

All the above appointments will be made within the Grade A.P.T. II (Metropolitan) (£675 to £800 p.a.) of the National Salary Scales for Gas Staffs.

Applications, stating age, qualifications and experience, should reach the Personnel Officer, Woodall House, 685, Lordship Lane, London, N.22, not later than 1st January, 1952. E6723

HIS MAJESTY'S COLONIAL SERVICE

PUBLIC WORKS DEPARTMENT

EXECUTIVE ENGINEER

Applications are invited for the following post:—EXECUTIVE ENGINEER (27322/13), Public Works Department, Sierra Leone. Duties will include work on investigation, design, construction and maintenance of civil engineering projects embracing roads, bridges, buildings, water supplies, and drainage. Appointment may be either on probation for permanent and pensionable employment or on contract in the salary scale £720 to £1300 per annum. Point of entry will be determined by approved professional experience, age and war service. A generous cost-of-living allowance is payable.

Conditions of appointment include furnished quarters at rent of from £60 to £90 per annum, first-class passages by sea or air on appointment and on leave on full pay at the rate of seven days in the United Kingdom for each month's resident service. The superannuation rights of candidates in local government service in the United Kingdom can be preserved. Candidates, preferably not over 35, should either be Corporate Members of the Institution of Civil Engineers or possess a Degree or Diploma exempting from Sections A and B of the A.M.I.C.E. examinations. They should have had at least two years' practical experience on civil engineering work after obtaining their qualifications.

Intending candidates should apply in writing to the Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, S.W.1, giving brief details of their age, qualifications and experience. They should mention this paper and quote the reference number 27322/13. E6825

PUBLIC NOTICES

HIS MAJESTY'S COLONIAL SERVICE

PUBLIC WORKS DEPARTMENT

EXECUTIVE ENGINEER

Applications are invited for the following post:—EXECUTIVE ENGINEER, Gold Coast (27322/193), Public Works Department. The duties of the post will include the preparation of surveys, design, estimates and working drawings for the construction of civil engineering works, such as roads, bridges, buildings, water supplies and drainage. Appointment will be on contract gratuity terms for two tours of service of from 18–24 months' duration, plus consequential leave. Candidates must have a pass in or exemption from Sections A and B of the Institution of Civil Engineers examination for associate membership, and have had at least five years' civil engineering experience. Previous experience in tropical countries will be advantageous.

Consolidated salary up to £1600 per annum, according to qualifications and experience. A gratuity at the rate of £37 10s. per quarter is payable at the end of the contract. Free passages on first appointment and on leave are provided for the officer and his wife once each way during each tour of duty. Free passages also for a maximum of three children under nine years of age, conditional on their residing in the Colony for a minimum period of six months during the officer's tours. Free medical attention is provided for the officer and his family and furnished quarters are available at a rental of £150 per annum.

Intending candidates should apply in writing to the Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, S.W.1, giving brief details of their age, qualifications and experience. They should mention this paper and quote the reference number 27322/193. E6862

MINISTRY OF LABOUR AND NATIONAL SERVICE

COMMONWEALTH RELATIONS OFFICE

MECHANICAL ENGINEER

Applications are invited by the Commonwealth Relations Office for a MECHANICAL ENGINEER, who would be responsible to the Punjab Government, P.W.D. Irrigation Branch for planning a new workshop for the manufacture and overhaul of heavy valves, gearing, winches, pumps, parts of earth-moving machinery, steam rollers and other heavy equipment. Applicants, A.M.I.Mech.E. preferred, over 45 years of age, must have previous experience as above and be able to train officers of the Department and work as a consultant. The appointment is for six months in the first instance, salary £2000 to £3000 per annum, according to qualifications and experience. Free passages and accommodation in the Punjab.

Application forms and further information obtainable from the Ministry of Labour and National Service, Technical and Scientific Register (A.S.12), Almack House, 26-28, King Street, St. James's Square, London, S.W.1, quoting A.12/P.E.26. E6871

NORTH-WESTERN GAS BOARD

SAFETY OFFICERS

Applications are invited for three positions as SAFETY OFFICERS for various works in the Manchester and Liverpool areas of the Board at salaries within A.P.T. Grade 9 (£570–£670 per annum), according to qualifications and experience.

The successful applicants will be required to carry out the routine inspection of works and premises, to investigate and report on accidents and to advise on all matters designed to promote safe working conditions. A knowledge of engineering and/or the general requirements of the Factories Acts will be an advantage.

The successful applicants may be required to pass a medical examination and subscribe to such superannuation scheme as the Board may adopt.

Applications, stating age, qualifications, experience and details of previous appointments, together with the names and addresses of two referees, should reach the Secretary, North-Western Gas Board, Bridgewater House, 60, Whitworth Street, Manchester, 1, within fourteen days of the publication of this advertisement. E6869

METROPOLITAN WATER BOARD

APPOINTMENT OF ASSISTANT MECHANICAL ENGINEER

An ASSISTANT ENGINEER (MECHANICAL) is required on the permanent pensionable staff. Salary scale £655–£810 per annum. Commencing salary according to age, qualifications and experience. Maximum age 45 years. It is a condition of the appointment to and the continued holding of this position that the selected candidate shall be, and continue to be, a subscribing member of the Institution of Mechanical Engineers.

Applicants must have had responsible experience in the lay-out, specification, design and installation of all types of plant applicable to the pumping of water, including high and low-tension electric drive, steam-raising plant and oil engines. The person appointed will be required to advise on the economic purchase and operation of pumping plant.

Particulars and a form of application may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope, quoting reference (K).

W. S. CHEVALIER,
Clerk of the Board.

Offices of the Board, New River Head, Rosebery Avenue, London, E.C.1. E6710

PUBLIC NOTICES

BATH HOSPITAL MANAGEMENT COMMITTEE

ENGINEER-IN-CHARGE

Applications are invited from suitably qualified engineers for the position of ENGINEER-IN-CHARGE of the following hospitals situated at Combe Park, Bath:—

Royal United Hospital.
Manor Hospital.
Bath and Wessex Orthopædic Hospital.
Forbes Fraser Hospital.
Spa Nurses' Home, Bath.

The salary will be £510 by £20 to £610 per annum. The appointment will be subject to the National Health Service (Superannuation) Regulations, for which a deduction of 6 per cent will be made from salary. The qualifications accepted include the Higher National Diploma or Certificate in Mechanical Engineering and the First-Class Certificate of Marine Engineering. Applications, stating age, qualifications and experience, to be addressed to the undersigned within 14 days of this advertisement.

J. LAWRENCE MEARS,
Secretary.

Manor Hospital,
Combe Park, Bath. E6827

CITY OF LIVERPOOL

WATER DEPARTMENT

VYRNWY AQUEDUCT—FOURTH INSTALMENT

ASSISTANT RESIDENT ENGINEER (TEMPORARY)

Applications are invited for the above appointment. Salary £645–£710 per annum (A.P.T. Grade V1).

Candidates should be suitably qualified with experience in the construction of civil engineering works, including surveying, levelling, setting out, measuring up and preparation of record drawings.

It is probable that the work will extend over a period of two years, but, in any case, the appointment will be subject to one month's notice on either side and to the Standing Orders of the City Council.

Application forms obtained from "The Water Engineer, 55, Dale Street, Liverpool, 2," must be returned by 31st December, 1951.

Canvassing disqualifies.

THOMAS ALKER,
Town Clerk.

Municipal Buildings,
Liverpool, 2 (J.A.2781). E6846

CITY OF WAKEFIELD

APPOINTMENT OF DEPUTY WATERWORKS ENGINEER AND MANAGER

Applications are invited for the appointment of DEPUTY WATERWORKS ENGINEER AND MANAGER at a salary in accordance with Grade VIII of the A.P. and T. Division of the National Scale of Salaries (£735, rising to £810 per annum). Housing accommodation may be made available for the successful candidate.

Candidates, whose age should not exceed 45 years, must be Corporate Members of the Institution of Civil Engineers and must have had considerable experience of the administrative work of waterworks undertaking.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the successful candidate will be required to pass a medical examination. Canvassing will disqualify and every applicant must disclose in writing whether to his knowledge he is related to any member or senior officer of the Corporation.

Applications, stating age, qualifications and experience, together with copies of three recent testimonials, and endorsed "Deputy Waterworks Engineer," should reach the undersigned not later than 7th January, 1951.

W. S. DES FORGES,
Town Clerk.

Town Hall,
Wakefield,
December, 1951. E6845

MINISTRY OF LABOUR AND NATIONAL SERVICE

ATOMIC ENERGY RESEARCH ESTABLISHMENT

ASSISTANT DIRECTOR (ENGINEERING)

ASSISTANT DIRECTOR (ENGINEERING) required for Atomic Energy Research Establishment at Harwell, Berkshire. Qualifications: British, of British parentage; Corporate Membership of one of the Institutions of Civil, Mechanical or Electrical Engineers or exempting qualifications; full workshops apprenticeship followed by design and drawing-office experience; successful record of management of large engineering works engaged in manufacture of wide variety of plant and apparatus essential. Duties: responsible to chief engineer for direction and management of large engineering workshop and drawing-office engaged in manufacture of wide variety of experimental plant mostly to high standards of precision. Salary: within the range £1420–£1650 per annum. House available, if married.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26, King Street, London, S.W.1, quoting Ref. C/51A. Closing date 5th January, 1952. E6851

PUBLIC NOTICES

ECTRICITY SUPPLY BOARD, IRELAND

ECHANICAL AND ELECTRICAL ENGINEERS

Electricity Supply Board invites applica- from :—
University graduates with Degrees in Mech- or Electrical Engineering;
Corporate Members of the Institution of anical or of the Institution of Electrical eers;
Graduates of the Institution of Mechanical or Institution of Electrical Engineers.
ances exist in the Board's organisation for :—
SHIFT ENGINEERS in generating stations; g hours per week 42.
NON-SHIFT ENGINEERING and TECH- L POSITIONS in generating stations and s departments.
posts under (A) the salary scale applicable is 646 (including cost-of-living bonus) plus an ance of 12½ per cent. in respect of shift work.
erence will be given to candidates who have uitable experience in a modern steam generat- ation or in a railway or dockyard works or in works of a manufacturer of generating station anical plant.
post under (B) the salary scale for staff g a University Degree or Corporate Member- of either of the institutions is £483–£846 ding cost-of-living bonus); the scale for ates of the institutions will depend on qualifi- ns and experience.
n application should state briefly candidate's technical training and qualifications, date of ation or corporate membership, and practical rience, and should indicate the type of vacancy hich the candidate wishes to be considered. applicant wishes to be considered for alter- e types of employment, his order of choice d be stated.
pplications should be addressed to the Per- l Officer, 27, Lower Fitzwilliam Street, in, and should reach him not later than Satur- 5th January, 1952.

PATRICK J. DEMPSEY,
Secretary.

h December, 1951. E6879

ON AND DORSET RIVER BOARD

WO ENGINEERING ASSISTANTS

pplications are invited for the above appoint- s, which will be in connection with major improvement works.
he conditions of service will be those of the nal Joint Council for Local Authorities, inistrative, Professional and Technical and al Services, and the salary scale will be £530 rising to £575 p.a. (A.P.T. Grade IV). Travelling subsistence allowances will be paid according he scale in force from time to time. (The imum car allowance payable is in respect of a H.P. or 1414 c.c. car on the N.J.C. Essential e Scale.)
andidates should be good draughtsmen and e had experience on extensive surveys and erence will be given to applicants with experi- of river works.
he appointments are terminable by one month's ce on either side and are subject to the pro- ons of the Local Government Superannuation 1937.
pplications, together with copies of not more three testimonials, must be delivered to the ersigned not later than Friday, the 18th uary, 1952.

N. MEDRINGTON, A.M.I.C.E.,
Chief Engineer.

St. Stephen's Road,
Bournemouth,
13th December, 1951. E6842

ROCHDALE AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE

BIRCH HILL HOSPITAL

APPOINTMENT OF ASSISTANT ENGINEER

Applications are invited for the above position. ndidates should have completed their practical ining and have taken the Ordinary National ificate in Mechanical Engineering or equivalent alification. Salary will be £400, rising by annual rements of £15 to £475 per annum.—Applica- s, containing age, experience, qualifications, the names of two persons to whom reference y be made, should be forwarded to the Secretary, ntral Offices, Birch Hill Hospital, Rochdale, hin ten days of the appearance of this adver- ment. E6893

HE BETHLEM ROYAL HOSPITAL ND THE MAUDSLEY HOSPITAL

ASSISTANT ENGINEER

pplications are invited for the position of ISTANT ENGINEER. Salary scale of £400 £15 to £475, with the addition of London ghting (£30 p.a. if age 26 or over). Candidates uld have completed their practical training in hanical engineering and preferably have the inary National Certificate in Mechanical Engi- ring. Experience in electrical engineering would an advantage. Whitley Council terms and con- ons of appointment and the National Health vice superannuation scheme will apply.—Appli- on forms, which must be returned not later than days after the date of the advertisement, may obtained from the House Governor, The udsley Hospital, Denmark Hill, S.E.5. E6888

PUBLIC NOTICES

SURREY COUNTY COUNCIL

COUNTY ARCHITECT'S DEPARTMENT

ASSISTANT MECHANICAL ENGINEER, GRADE VI

Applications are invited for the appointment of ASSISTANT MECHANICAL ENGINEER, Grade VI, at a commencing salary of £645 per annum, rising by annual increments of £20/£25 to a maximum of £710 per annum, plus London allowances of up to £30 per annum, according to age.

Applicants should be Corporate Members of the Institution of Mechanical Engineers and/or Institution of Heating and Ventilating Engineers, and should be experienced in the preparation of specifications, drawings and estimates for the installation and maintenance of heating, ventilating and hot water supply services in large buildings.

The appointment will be subject to the provisions of the Local Government Act, 1937, and the successful applicant will be required to pass a medical examination.

Applications, stating age, qualifications and experience, and accompanied by copies of three recent testimonials, should be sent to the County Architect, Surrey County Council, County Hall, Kingston upon Thames, not later than the 5th January, 1952.

Canvassing, either directly or indirectly, will disqualify a candidate for consideration.

The Council will be unable to provide any housing accommodation and the successful applicant will be expected to make his own arrangements in this direction. E6829

NORTH THAMES GAS BOARD

CHIEF ENGINEER'S DEPARTMENT

DRAUGHTSMEN

The following drawing-office staff are required in the Chief Engineer's Department :—

(1) JUNIOR DRAUGHTSMEN (three), at Beckton, E.6, Slough, Bucks, and Lea Bridge, E.10. Applicants should preferably have had some experience in the maintenance of gas plant and be conversant with the design of steel structures and lay-out of buildings. Starting salary within the range £295 per annum to £535 per annum, according to age, qualifications and experience.

(2) DRAUGHTSMEN (two) at Westminster :

(a) Experienced in the design, lay-out and detailing of mechanical handling plant.

(b) Experienced in the design, lay-out and detailing of any of the following :—Coal carbonising plant, coke-oven plant, by-products plant, pipe lay-outs or steel-framed structures.

Applicants should be about 30 years of age. Starting salary within the range £570 per annum to £650 per annum, according to age, qualifications and experience.

All the above appointments are of a permanent nature and pension arrangements will be discussed at interview.—Applications, stating age and full particulars of training and experience, should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference number 79. E6636

METROPOLITAN WATER BOARD

APPOINTMENT OF ASSISTANT ELECTRICAL ENGINEERS

ASSISTANT ENGINEERS (ELECTRICAL) required on permanent pensionable staff. Salary scale £655–£810 per annum. Commencing salary according to age, qualifications and experience. Maximum age 45 years. It is a condition of the appointment to and the continued holding of these positions that the selected candidates shall be and continue to be, subscribing members of the Institution of Electrical Engineers.

Applicants must have had responsible experience in the lay-out, specification, design and installation of electrical plant applicable to the pumping of water, including high-tension substation design and installation, A.C. and D.C. motors and control gear, automatic systems, general lighting and telephones. The persons appointed will be required to advise on the economic purchase and operation of electrical plant.

Modern house available in good neighbourhood, if required, at inclusive rent of £125 per annum.

Particulars and a form of application may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope, quoting reference (A).

W. S. CHEVALIER,
Clerk of the Board.

Offices of the Board, New River Head, Rosebery Avenue, London, E.C.1. E6718

WAR OFFICE

ASSISTANT TECHNICAL OFFICER

The War Office have a vacancy in London for an ASSISTANT TECHNICAL OFFICER. Applicants should have served an apprenticeship in electrical engineering and hold a Higher National Certificate with electrical subjects, or preferably be Corporate Members of the I.E.E. Experience in technical administration and service with the Armed Forces would be an advantage. Duties are concerned with the organisation of maintenance and repair of Army electrical equipment other than telecommunication, e.g., generators, charging sets and batteries, &c. Salary scale is £675 to £825 p.a. and point of entry will be in accordance with age, qualifications and experience. The post is unestablished, but there are possibilities of establishment. —Application forms obtainable from Technical and Scientific Register (K), Almack House, 26-28, King Street, London, S.W.1, quoting D.256/51-A. Closing date 12th January, 1952. E6870

PUBLIC NOTICES

WEST KENT MAIN SEWERAGE BOARD

APPOINTMENT OF ENGINEERING ASSISTANT

Applications are invited for the appointment of ENGINEERING ASSISTANT, Grade V, A.P. and T. Division, £600 by £15 by £20 to £650 p.a. It will be an advantage if applicants are Chartered Civil Engineers, but applicants holding other appropriate professional qualifications supported by experience of hydraulic and/or structural engineering will be considered. The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the candidates selected will be required to pass a medical examination by the Board's medical adviser and, if appointed, to devote their whole time to the duties of the office. Applications, in candidates' own handwriting, endorsed "Engineering Assistant," giving details of age, training, qualifications, experience, and present and past appointments, together with the names of three referees, must be delivered to the undersigned. Canvassing will disqualify.

EDMUND POCKNELL,
Secretary.

"Barnfield,"
20, Blyth Road,
Bromley, Kent. E6795

ADMIRALTY

ADMIRALTY RESEARCH AND DEVELOPMENT ESTABLISHMENTS

ELECTRICAL AND/OR MECHANICAL ENGINEERING DRAUGHTSMEN

Vacancies exist for ELECTRICAL and/or MECHANICAL ENGINEERING DRAUGHTSMEN in Admiralty Research and Development Establishments located in the vicinity of Weymouth, Portsmouth, Teddington (Middlesex) and Baldock, Herts.

Draughtsmen experienced in light current, electro-mechanical, precision mechanical and electronic equipment are particularly needed.

Candidates must be British subjects of 21 years of age and upwards, who have had practical workshop experience (preferably an apprenticeship), together with drawing-office experience.

Appointments will be in an unestablished capacity but opportunities will occur for qualified staff to compete for established posts.

The salaries offered, depending on age, experience, ability and place of duty, will be within the range £320–£575 p.a.

Hostel accommodation is available at some Establishments.

Applications, stating age and details of technical qualifications, apprenticeship (or equivalents), workshop and drawing-office experience, should be sent to Admiralty (C.E.II, Room 93), Empire Hotel, Bath, quoting DM/R.D. Original testimonials should not be forwarded with application.

Candidates required for interview will be advised within two weeks of receipt of application. E6424

UGANDA ELECTRICITY BOARD

OWEN FALLS HYDRO-ELECTRIC POWER STATION

TENDERS are invited for the SUPPLY, DELIVERY (F.O.B. British port) and INSTALLATION of 11kV and LOWER VOLTAGE CABLES and ACCESSORIES associated with generation plant and feeder circuits. Form of Tender, conditions and specification, No. UEB.41/26, in triplicate, may be obtained from Messrs. Kennedy and Donkin, Alliance House, 12, Caxton Street, London, S.W.1, on or after 2nd January, 1952, on payment of a deposit of £2 2s., which will be refunded upon receipt of a bona-fide Tender or return of documents. Extra copies of the contract documents may be obtained at £2 2s. per set, which sum will not be returnable. Cheques should be made payable to the Uganda Electricity Board.

Tenders must be submitted in duplicate in a sealed envelope endorsed on the left-hand corner "Tender for Specification UEB.41/26," and addressed to the Chairman, Uganda Electricity Board, c/o Messrs. Kennedy and Donkin, Alliance House, 12, Caxton Street, London, S.W.1, and delivered not later than 12 o'clock noon on the 11th February, 1952.

The Board do not bind themselves to accept the lowest or any Tender. E6894

MINISTRY OF SUPPLY

ENGINEER

ENGINEER required for Ministry of Supply Establishment near Sevenoaks, Kent. Qualifications : British, of British parentage; engineering apprenticeship and either a Degree in Mechanical Engineering or Corporate Membership of the Institution of Mechanical Engineers. Some years' experience in a mechanical engineering drawing-office and the ability to control a team of design engineers. Experience of working in close contact with scientific staff an advantage. Duties : to solve problems in the design and development of a wide variety of prototype machines and equipment (e.g., large camera equipment, specialised machine tools, moulds and dies for specialised purposes), working to very high precision. To act as Deputy to the Superintendent of Drawing and Design. Salary : Within the range of £1177–£1370 p.a. Not established, periodical competitions for established pensionable posts.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26, King Street, London, S.W.1, quoting Ref. No. C783/51A. E6889

PUBLIC NOTICES

NATIONAL COAL BOARD

PRODUCTION DEPARTMENT

ENGINEERING ASSISTANT

Applications are invited for the appointment of an ENGINEERING ASSISTANT (Building, Civil and Structural), in the Production Department at London Headquarters. Candidates must have had experience in the design and detailing of reinforced concrete framed structures. Preference will be given to candidates with a Higher National Certificate or Graduateship of the Institution of Structural Engineers.

Starting salary of up to £588 a year in London, depending on qualifications and experience.

Apply in writing, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/408. Original testimonials should not be forwarded. Closing date 5th January, 1952. E6840

ABERDEEN HARBOUR COMMISSIONERS

HARBOUR ENGINEER'S DEPARTMENT

JUNIOR ENGINEERING ASSISTANT

Applications are invited for the post of JUNIOR ENGINEERING ASSISTANT in the Harbour Engineer's Office, Aberdeen. Applicants should have drawing-office experience in general civil engineering design.

The salary rises, on age scale, from £335 at 25 years to £425 at 32 years. The appointment is subject to the Commissioners' superannuation scheme and the candidate selected will require to pass a medical examination before appointment.

Applications, stating age and qualifications, with full details of experience, together with copies of recent testimonials, should be lodged with the Harbour Engineer, 15, Regent Quay, Aberdeen, not later than 19th January, 1952.

Harbour Engineer's Office,
Aberdeen, 12th December, 1951. E6858

TENDERS

CITY AND ROYAL BURGH OF SCOTLAND

WATER DEPARTMENT

FAIRMILEHEAD FILTERS

WATER TURBINE AND GENERATOR

TENDERS are invited for the SUPPLY and ERECTION of a WATER TURBINE and 80kW ALTERNATOR, together with the necessary WIRING and SWITCHGEAR at Fairmilehead Filters, Edinburgh.

Further particulars may be had on application to the City Water Engineer, 6, Cockburn Street, Edinburgh.

Tenders, accompanied by full details of the plant referred to in the Tender, should be lodged with the Subscriber in a sealed envelope, endorsed "Fairmilehead Filters—Tender for Water Turbine and Generator," not later than 10 a.m. on Tuesday, 22nd January, 1952.

The Corporation shall not be bound to accept the lowest or any Tender.

J. STORRAR, S.S.C.,
Town Clerk.

City Chambers,
Edinburgh,
December, 1951. E6794

WHITEHAVEN CORPORATION WATERWORKS

LAKE ENNERDALE SCHEME

CONTRACT NO. 4A

PUMPING PLANT FOR SUMMER GROVE PUMPING STATION

The Corporation invite TENDERS for the PROVISION, ERECTION and MAINTENANCE of Electrically Operated PUMPING PLANT, including :

One Electric Motor and Pump, capacity of pump to be 785 gallons per minute against an average head of 218ft.

All Controls, Starters, Conductor Cables, Wiring, Pipework and Valves, Gauges, Meters and other Appurtenances, all in accordance with the drawings and specification prepared by Messrs. Rofe and Raffety, 3, Victoria Street, London, S.W.1. Copies of the specification and drawings may be obtained from the office of the engineers upon the payment of Two Guineas (by cheque only), which will be returned after the receipt of a bona-fide Tender.

Sealed Tenders, in a plain envelope, endorsed "Whitehaven Corporation Waterworks, Tender for Pumping Plant," and addressed to the undersigned at his office, must be received on or before the 24th January, 1952.

The Corporation do not bind themselves to accept the lowest or any Tender.

W. H. J. BROWNE,
Town Clerk.

Town Hall,
Whitehaven. E6749

For continuation of Small Advts., page 4

COMPANY MEETING

HALE & HALE (TIPTON)

REPUTATION OF PRODUCTS FURTHER ENHANCED.

MR. W. EDGAR HALE'S REVIEW.

THE fifteenth annual general meeting of Hale and Hale (Tipton), Ltd., was held on December 19 at Dudley, Mr. R. C. LEPPINGTON (Vice-Chairman and Managing Director) presided in the absence of the Chairman, Mr. W. EDGAR HALE, M.I.Mech.E., M.Inst.F.

The following is an extract from the Chairman's circulated review :—Our trading during the year has been quite a successful one, and we have enhanced still further the already excellent reputation that our company has for its products.

Parent Company.—The profit and loss account shows a trading profit of £89,963, as compared with £73,162, and there remains a balance of £36,147 representing the net profit for the year, an increase of £6399. Your Directors recommend a final dividend of 17½ per cent., less tax, making a total distribution for the year of 25 per cent., less tax, as compared with 20 per cent. for the previous year. This final dividend takes £9188 and it is proposed that an amount of £20,000 be transferred to general reserve account to leave a balance to be carried forward of £12,958.

The consolidated trading profit for the year amounts to £120,077, as compared with £78,362 ; the consolidated net profit is £50,241, an increase of £13,506. After giving effect to the dividends already paid and the appropriations as recommended, there remains a balance of £16,878 to be carried forward, as compared with £27,204 brought forward.

PRODUCTION, SALES AND MANAGEMENT

On our sales side, we are continuing to divide up our production by the exercise of the best method possible. Our Blackheart malleable iron castings, and also our new product which we are selling under the name of " Fermalite," are exceedingly popular, and I do not think I am exaggerating the position when I state that there is nothing quite so good on the market.

Our products are supplied to almost every branch of the engineering industry, and it would be difficult to visualise any commercial organisation having a more secure foundation upon which to build its goodwill ; thus one can be fairly certain that when one branch of engineering is having a lean time, some other section will be having the opposite.

With the rearmament programme, which is engaging our attention, the question of supply and demand is going to present an obstacle, but we are using our best endeavours to increase production, and for this purpose we visualise quite a considerable capital expenditure during the current trading year.

We have introduced during the year a very interesting appliance for materially improving upon the present method employed in the launching of ships. The first launch took place recently of an ocean-going oil tanker, and the result was excellent.

We are a well-balanced team, both in respect of management and production. The success of this enterprise is due to the energy and determination of everyone associated with it that makes it the powerful force it is in the industry to which it belongs.

Our financial position as a company is excellent and is the outcome of taking much care of our finances for many years. One can only describe them as definitely satisfactory.

RAW MATERIAL SHORTAGES

It is well known that world supplies of metallic ores, fuels and all other basic materials are already in very short supply, due, in the main, to the over consumption of these supplies in the attempt to improve the standards of living everywhere. The present supplies are really insufficient to keep a first-class peace programme working to the full, so that the extra demand necessary for arms production is going to be exceedingly difficult to fulfil. It becomes self-evident that, as a nation, we are going to be deprived of some of the important necessities of life, and the consuming public have just got to suffer and put up with it.

Then there is the all-important question of fuel. We have, of course, suffered fairly considerable inconvenience at times in regard to supplies of solid fuel, gas and electricity, and there is no gainsaying the fact that our national position in respect of these vital supplies is worsening, and here, again, the solution is most difficult. The using of less fuel in producing finished articles has made some slight alleviation, and this process will be continuous ; but it is all so slow. Nevertheless, it is at least a crumb of comfort.

In mentioning the very important adverse problems with which we are faced nationally, the inclination is to be pessimistic, but if we meet our troubles in the same bold spirit we have adopted in the past, I am sure we shall eventually reach a brighter period.

The report was adopted.

TENDERS

INDIA

LOCOMOTIVE BOILERS

The High Commission of India invites TENDERS for the SUPPLY of :—

(Ref. S.3637/51), Group 3, 14 by 2ft. and 2ft. 6in. gauge LOCOMOTIVE BOILERS ;

(Ref. S.3694/51), Group 4, 35 Broad-Gauge LOCOMOTIVE BOILERS, of various types.

Forms of Tender can be obtained from the Director-General, India Store Department, 32/44, Edgware Road, London, W.2, at a fee, which is not returnable, of 10s. per group.

Tenders are to be delivered by 2 p.m. on 22nd February, 1952. E6887

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A BIRMINGHAM ENGINEERING company invites applications for the position of General Manager. Engineering apprenticeship followed by executive experience and a high standard of technical qualifications essential. Position will be permanent and requires an individual of tactful approach and outstanding organising ability ; it also offers good prospects to the right man. Pension scheme is operated and attractive remuneration will be offered to the applicant possessing the necessary qualifications. Age 35 to 45. Write, giving full particulars of education, qualifications and experience, and state age.—BOX No. E6661, " The Engineer." A

A BRITISH FIRM of contractors and civil engineers operating in Malaya and Borneo require an Assistant Engineer for work at their Head Office, Singapore, connected with public works contracts in Borneo, both civil engineering and building projects, including design work.—Write with full particulars to BOX " DE/72," c/o 95, Bishopsgate, E.C.2. E6878 A

A COMPANY manufacturing small diesel and petrol engines and fuel injection equipment on a quantity basis require the following staff :—Two Senior Jig and Tool Designers, two Junior Jig and Tool Designers. The factory is situated in country surroundings within half an hour of the West End of London. The work is interesting, working conditions are exceptionally good. There is a pension scheme, modern social and welfare facilities and assistance is given in finding accommodation. Remuneration is by merit and salaries are reviewed bi-annually.—BOX No. E6890, " The Engineer." A

A DIE DESIGNER for gravity die casting is required by well-known firm of aluminium founders in London area. Applicant must have had wide experience of modern gravity die technique and be able to supervise design, manufacture and foundry operation. This is a staff appointment, pensionable and carries a good salary with excellent opportunity of advancement. Applicants should write, giving full details of experience and qualifications, which will be treated in strict confidence.—BOX No. E2501, " The Engineer." A

A MECHANICAL ENGINEER is required for work concerned with production processes in the heavy mechanical engineering works of the English Electric Co., Ltd., at Rugby. Previous design experience of machine tools is desirable, but the essential requirements is mechanical design ability coupled with a sound knowledge of machine tools.—Please write, giving full details and quoting ref. 342, to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham Street, London, S.W.1. E6746 A

A MECHANICAL ENGINEER, with H.N.C. qualifications, is sought by a company producing machines for processing plastics. While experience in plastics engineering is not essential, applicants should be able to develop a design from basic facts and suggested schemes, and also to show some originality of thought. The minimum salary offered is £533 per annum, with advances according to qualifications and manifested ability. Intending applicants resident in S.W. London and W. Surrey should find the above offer most challenging.—BOX No. E2486, " The Engineer." A

A PROGRESSIVE and rapidly expanding company with branches in all parts of the U.K. wishes to appoint a young academically qualified Engineer to train for an engineering post of some responsibility. The length of the training will depend upon progress made and ability shown, but is not expected to be in excess of two years. Applicants must be single, not more than 28 years of age and must be prepared to move at short notice to any of the company's works for indefinite periods of up to 12 months. Experience is not essential, but the minimum qualification which will be considered is Higher National Certificate held in conjunction with a five-year apprenticeship. The commencing salary offered is from £450 per annum to £600 per annum, but a man of the right calibre would stand an excellent chance of rapid promotion. Write, giving brief details of age, qualifications and experience, quoting the Reference PE/TE. Application forms will be sent to the most suitable candidates.—BOX No. E6883, " The Engineer." A

AN AUTOMOBILE ENGINEER of the highest calibre is required in the Midlands for a post of very considerable importance and carrying great responsibility with a large firm of world-wide reputation. The man selected will be expected to control design and development ; he must have had extensive experience in the design of cars or trucks and possess administrative ability. Applications are invited from men between 40 and 55. Salary will depend upon the knowledge and experience the man can bring to the company. Specialist Automobile Design Engineers are also required, who must have had sound design experience in one or more of the following fields :—Automobile engines, chassis, bodies, transmission, braking systems and electrical equipment. A Metallurgical Specialist is required in addition for material development. Salary, pensions, &c., can be arranged to suit the right men. All applications will be treated in the strictest confidence.—BOX No. E6785, " The Engineer." A

SITUATIONS VACANT

A PROGRESSIVE COMPANY, situated South West of London, have a vacancy for Plate Shop Foreman. Applicants must be conversant with welded construction methods. Apply in writing, giving details of experience and salary required.—BOX No. E2502, " The Engineer." A

A WELL-KNOWN industrial firm has a vacancy in its production department for a young Man with drive and willingness to take progressive responsibility. Excellent prospects are offered to the successful applicant, who should have a public school education, Degree or A.M.I.Mech.E., standard of technical qualification and a good apprenticeship. Good experience of modern production methods is essential. Applicants must be under 35 years of age and the post carries a high salary according to experience. Full details of qualifications and previous posts should be sent in confidence.—BOX No. E6884, " The Engineer." A

A WIDE SELECTION of positions vacant, including Production/Planning Engineers ; Consulting, Design, Time Study Engineers ; Draughtsmen and Tracers ; Inspectors ; Foremen, &c., for light and medium engineering. Inquiries invited without obligation and in confidence.—Technical Employment Agency, 179, Clapham Road, S.W.9. E348 A

AN OLD-ESTABLISHED FIRM engaged in the woodworking and light engineering industry, situated 30 miles from London, requires the services of a Chief Engineer, under 40, to take charge of all plant and premises maintenance, tool room, heating, electricity supply, exhausting and ventilating, and to act in an advisory capacity to the management on engineering matters concerned with production. The appointment warrants a four-figure salary. Only those having at least five years' plant engineering experience need apply.—BOX No. E2563, " The Engineer." A

APPLICATIONS ARE INVITED for the following positions in the London area :—Planning Engineers and Tool Designers. Applicants must have experience on aero materials and modern machine shop practice. Also Senior Methods Engineers, Electrical and/or Mechanical, with experience on development work in production shops. The positions are superannuated and offer considerable scope to men with adequate experience.—Write, giving full details in strictest confidence, to the Employment Officer, Rotax, Ltd., Chandos Road, Willesden Junction, N.W.10. E2588 A

APPLICATIONS ARE INVITED for the position of Works Manager with a large engineering firm in the Midlands. The successful applicant will be required to take full charge of the manufacturing departments of the steam turbine division. Ability to plan, organise, and control production of heavy and light machine shops and fitting shops is essential. High salary and excellent conditions, including pension scheme. Please apply in confidence, giving full details of training, qualifications, experience and present salary.—BOX No. E6816, " The Engineer." A

APPLICATIONS ARE INVITED from Draughtsmen for design and detail work on land or marine steam turbines at the Rugby works of the English Electric Company. These are permanent positions, offering excellent prospects. Men with good mechanical D.O. experience will be considered. Generous pension and bonus schemes in operation.—Write, giving full details of qualifications and experience, mentioning ref. 504E, to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham Street, London, S.W.1. E6620 A

APPLICATIONS ARE INVITED from qualified Mechanical Engineers for the position of Works Engineer to a large company manufacturing laminated plastics and coated textiles. Applicants must have technical training and experience with steam and electrical plant.—Applications in writing, giving full details of qualifications and experience, to BOX No. E2512, " The Engineer." A

APPLICATIONS are invited from Senior and Intermediate Draughtsmen for work in connection with gas and coke-oven plants. Experience in one of the following is desirable :—(1) Design and detailing of steel structures ; (2) general engineering and lay-out of mechanical equipment ; (3) lay-out and detail of tanks, pipework and special apparatus. Good conditions of employment. Five-day week. Canteen.—State age and details of experience to the Personnel Officer (D.O.), The Woodall-Duckham Co., 63/77, Brompton Road, London, S.W.3. E199

APPLICATIONS are invited from Design Draughtsmen and Stressmen, also Technical Assistants, with combined design and performance experience, to work on both reciprocating and gas turbine aero-engines.—Applications should state full particulars of experience and qualifications and should be addressed to the Personnel Manager, The de Havilland Engine Co., Ltd., Stonegrove, Edgware, Middlesex. E139 A

ASSISTANT CHIEF ENGINEER required by heavy chemical manufacturers in the Manchester area. Applicants for this post should be under 40 years of age and have had a sound practical training with technical qualifications to at least H.N.C. Experience in the maintenance and construction of heavy chemical plant, together with sound knowledge of steam production and distribution are essential. Experience of planned maintenance and job planning operations, whilst not essential, would be of assistance. Salary £1200/£1400 p.a. The successful applicant will be expected to pass a medical examination for admission to the company's superannuation scheme. Replies, giving full details.—BOX No. E2554, " The Engineer." A

ASSISTANT for technical publications department of engineers, West London area, for compilation of spares lists, service instructions, &c. Must have had experience in similar department with engineers. Five-day week. State age, experience and salary required.—BOX No. E6834, " The Engineer." A

ASSISTANT to General Manager required by old-established firm light and medium precision engineers, North of England. Successful applicant will be responsible to general manager for production and routine works administration. Previous experience in executive or senior post of similar nature with up-to-date experience modern machine shop plant, factory organisation and handling mixed labour essential. Write full particulars, qualifications, experience, present position and salary.—BOX No. E2565, " The Engineer."

SITUATIONS VACANT

ASSISTANT TO MANAGING DIREC required for medium-sized, old-established and marine engineering works, Sou England. Wide managerial experience and ledge of all departments essential, including repairs. Exceptionally good prospects.—BO E2586, " The Engineer."

BOILER DRAUGHTSMAN - ESTIMA capable of handling shell boiler contracts, in all auxiliaries. Good salary, comfortable co Lancashire. Reply, stating details of educati experience in chronological order.—BOX E6865, " The Engineer."

BRITISH CELANESE, LIMITED, requ Civil Engineer for their planning and develop department at Head Office, London. A gra who is a Corporate Member of the Institu of Civil Engineers is required who has a p tical knowledge of soil mechanics, site investig construction and lay-out of modern factory b ings, water and drainage services, &c. Exper in preparing specifications, estimating costs checking quantities is also desirable. The senior position and salary will be commen with the responsibilities of the post.—Applica enclosing particulars of career and qualifica should be sent to the Personnel Manager, B Celanese, Limited, Celanese House, 22 and Hanover Square, London, W.1.

BRITISH CELANESE, LIMITED, requ Senior Draughtsman with experience of lay-out, for their Engineering Development D ment, London. Salary will be in accordance qualifications and experience, and the succ applicant will be required to join the staff pe fund.—Applications, enclosing full partic should be sent to the Personnel Manager, B Celanese, Limited, 22, Hanover Square, Lo W.1.

BRITISH ENGINE BOILER and El Insurance Company, Ltd., 24, Fennel Manchester, 4.—The company requires addi Lift and Crane Inspectors. Permanent po with progressive salary scale £520 to £750 and contributory pension. Candidates age 28 to years, with sound training embracing machinery and having electrical and mech experience, are invited to apply in own handwr stating age, qualifications and experience.

BUYER of electrical components required important Midland machinery manufactu act under chief electrical engineer for the p of buying electrical components, including up to 50 B.H.P., switchgear, transformers, matic and electronic controls, thermostats Duties will include, inter alia, the implemen of design requirements in terms of bought-out trical parts.—Applications, which should in details of age, training, previous experience salaries earned, are invited from suitably qua candidates, and should be addressed to BOX c/o Charles Barker and Sons, Ltd., 31, Budge London, E.C.4.

BUYER, with experience and contacts for h rolled steel sections, R.S.J.s, angles, chan tees, flats, plates, &c.—Full details and ex required to H. and C. Davis and Co., Ltd., 50, Town, Clapham, S.W.4.

CEYLON.—Engineer, regularly trained a indentured, with works, drawing-office and gen outside experience, to assist director, general m neering company, preparing estimates and sup vising outside work. Details of education, n nical certificates, inside and outside experience quired. Terms, conditions, applicable to Ceylo furnished to suitable applicants.—BOX No. " The Engineer."

CIVIL ENGINEERING CONTRACTO require Assistant to Manager. No upper age li for the appointment. Applicants should h experience in quantity surveying and be capa of building up estimates from components of r and plant hours. Experience in presentation interim and final accounts essential. Fullest det qualifications, experience, age and salary requir —BOX No. E2533, " The Engineer."

CIVIL ENGINEER, energetic young man lookin for overseas experience leading to progressive with old-established contractors. Must have h some experience general setting out and measu ment. Write full particulars.—BOX No. " The Engineer."

CIVIL ENGINEERS, Junior and Senior, requ in consulting engineer's office for the design heavy civil engineering works in connection w steam generating stations, tunnel, harbour, hyd electric and other works. Salary according qualifications and experience.—Applications, references to previous employers, to Sir Willi Halcrow and Partners, MM.I.C.E., Alliance Hou Caxton Street, Westminster, S.W.1.

CONTRACTS MECHANICAL ENGINEE required to deal with the organisation and plann of refinery or chemical plant through all stages mechanical design. University, Engineering Chemistry Degree preferred. Duties to be London with travel at intervals to sites ; age li 30/50. Salary according to experience and qu fications. Superannuation scheme.—BOX N 43, c/o Browns, 37, Tothill Street, S.W.1.

CRANE DRAUGHTSMEN.—Vacancies ex for experienced Draughtsmen in the detail drawi office of Cowans, Sheldon and Co., Ltd., Carl A vacancy also exists for one experienced Draug man-Designer. Applicants should give f particulars of age, experience and salary requir

DESIGNER DRAUGHTSMAN wanted, w experience of heavy engineering design a development. Knowledge of heavy steel mill p is preferable. Good prospects for experienced —Apply, Personnel Manager, Tube Investm (Group Services), Limited, Rocky Lane, Aston, Birmingham, 6.

DESIGNERS AND DRAUGHTSMEN London office, handling large oil refinery a chemical plant contracts. Experienced men r quired for the following categories :—Plant lay-o piping, structural and reinforced concrete foun tions. Good conditions, five-day week, pens scheme.—Write full particulars, age, qualificati and experience, to BOX 5454, c/o Charles Bar and Sons, Ltd., 31, Budge Row, London, E.C.4.

SITUATIONS VACANT

IGNER required for Westminster office of ructional engineers. Applicant should be perienced in the design of all types of steel ctures and capable of working on own initiative. ry up to £600 per annum. Write, stating age experience.—BOX No. E2604, "The Engi- ." A

TAIL AND JIG AND TOOL Draughtsmen ired for light engineering factory in Lanark- , Scotland. Housing prospects good.—BOX 2638, "The Engineer." A

RAUGHTSMAN, familiar with the design of tic moulds or press tools, is required by pro- er of moulds for the plastics trade. Congenial king conditions, with commencing salary of per annum offered. Age of applicants 23 years 30 years. Applicants should state their industrial erience when applying.—BOX No. E2455, e Engineer." A

RAUGHTSMAN (Junior) for the London area. Apply, Gwynnes Pumps, Limited, 64, Chancellors ad, Hammersmith, W.6. E452 A

RAUGHTSMAN required for engineering partment of large factory in West London area. plicants should be familiar with plant lay-out, luding the installation of medium and heavy ess equipment, piping, valves and conveyor tems. Design experience advantageous, ther with a knowledge of precision moulds. od salary paid to capable and experienced man. ply in confidence, stating age, experience, tech- al qualifications and positions held.—BOX No. 881, "The Engineer." A

RAUGHTSMAN, senior position for experi- ed young man, in firm commencing design of ht light to medium mechanical and electrical uipment. Workshop practical experience an ; Barnet district. Write, stating age, experi- e and salary required.—BOX No. E2594, "The gineer." A

RAUGHTSMEN AND STRESSMEN re- ired by aircraft firm in the Midlands for work on search, aerodynamics and stress analysis. Appli- tions are invited from men with an Aeronautical Mechanical Engineering Degree or equivalent alifications. The positions offer good prospects. ply, stating age, experience, &c.—BOX No. 639, "The Engineer." A

RAUGHTSMEN, with good mechanical design perience, required by water power engineers, ndon. Previous experience of hydraulics an vantage, but not essential. Age 25–40. Reply, ving full details of exp., age and salary reqd.— OX No. E6797, "The Engineer." A

RAUGHTSMEN.—Experienced men required boiler-house lay-outs, heating and ventilating, dustrial fan application or boiler design. Juniors quired for detail work. Five-day week.—Apply writing, full details, age, experience, &c., to Gen. anager, Bennett Engineering Co., 37, Soho Square, ondon, W.1. E2568 A

RAUGHTSMEN, mechanical engineering, re- ired by old-established general engineering firm. rmanent position with good salary and pension heme. Excellent canteen facilities. Five-day eek.—Write, The Airscrew Co. and Jicwood, Ltd., eybridge, Surrey. E5966 A

RAUGHTSMEN, having first-class experience the preparation of shop detail drawings for coal rbonisation plants and mechanical handling uipment, are required by West's Gas Improve- ent Co., Ltd., Columbia House, Aldwych, London, .C.2. E454 A

RAUGHTSMEN, Senior and Detail, required y large organisation in the Midlands, particularly ose with experience in the design of I.C. engines d passenger car independent suspension.—BOX o. E6818, "The Engineer." A

RAUGHTSMEN required for the maintenance partment of a large iron and steel works. Pre- ous experience in an iron and steel works not essential, but applicants should have a good know- dge of general mechanical and/or structural engi- ering. Permanent and pensionable positions, ith good salaries, offered to men aged between 25 d 50 years.—Apply, with full details, to the eneral Manager, Iron and Steel Works, Stewarts nd Lloyds, Limited, Corby, Northants. E6778 A

RAUGHTSMEN required, preferably with perience in the design of electric cranes and arging machinery for steelworks.—Write, The echanical Department, The Wellman Smith wen Engineering Corporation, Ltd., Parnell ouse, Wilton Road, London, S.W.1. E6764 A

RAUGHTSMEN.—Marine engineering firm on ydeside requires Senior Draughtsmen with design perience of (a) marine water-tube boilers, (b) arine turbines, or (c) pipe arrangements. Finan- al assistance given for house purchase if required. ension scheme in operation.—Write, stating age nd giving particulars of previous experience, to OX K.912, c/o Streets, 110, Old Broad Street, .C.2. E6562 A

RAUGHTSMEN (one Senior, one Junior), lectrical, age range 24–48, experienced L.T. ontrol gear, plant lay-out and diagrams. Must ave sound recognised apprenticeship and possess igher National Certificate or equal. Site within ay reach of Wolverhampton. Good pension cheme (compulsory), canteen facilities, five-day eek. State age, present salary, give references and etail apprenticeship training.—BOX No. E6611, The Engineer." A

LECTRICAL ENGINEER Draughtsman re- uired, with experience in the design and installa- ion of power and lighting schemes, distribution nd control diagrams, &c. Excellent prospects for uitable men offered by Tees-side firm. Apply, iving full particulars, quoting reference D.O.— OX No. E6852, "The Engineer." A

LECTRICAL ENGINEERS are required by oseph Lucas, Limited, for their design and evelopment laboratory. Applicants should be t least of H.N.C. standard with experience in the lectrical design of small motors and generators. he work is varied and interesting with excellent rospects for men with initiative and the required echnical ability. Junior Laboratory Engineers f O.N.C. standard are also required for testing nd investigational work on automobile electrical quipment.—Please reply, stating qualifications, xperience and age, to Personnel Manager, Joseph ucas, Ltd., Great King Street, Birmingham. E6886 A

ELECTRONIC ENGINEERS required for development work in Gloucestershire area. Good academic qualifications and apprenticeship. Experience in one or more of the following desirable: control systems, D.C. amplifiers, computing devices, video circuits, microwave techniques.—Apply, with full details of qualifications, age and salary required, to BOX No. A.C.67295, Samson Clarks, 57/61, Mortimer Street, London, W.1. E6252 A

ENGINEERING DRAUGHTSMAN required for development work covering variety of products in Westminster drawing-office. Experience of light mechanisms an advantage. Good salary, prospects and working conditions, including pension scheme and five-day week. Apply, stating age, experience, &c.—BOX No. E6821, "The Engineer." A

ENGINEERS, experienced in design of electro-mechanical equipment, required by new department of old-established S.E. London firm. The appointments are progressive and pensionable.—Write, fully stating age, details of education and past experience, to BOX E662, at 191, Gresham House, E.C.2. E6832 A

ENGLISH ELECTRIC Company, Limited, have a number of vacancies for Draughtsmen at their water turbine drawing-office at Acton, London. Specialised knowledge of water turbines is not essential and men with good mechanical D.O. experience are offered the opportunity to take up this interesting and expanding class of work. Generous pension scheme in operation.—Write, giving full details, quoting ref. 166A, to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham Street, London, S.W.1. E6570 A

ESSO PETROLEUM Company, Limited, Refinery Dept., Fawley, have the following vacancies on the staff of the technical department:—Supervisory posts: (a) Process Engineer, to supervise, plan and co-ordinate the work of the various sections of the technical department whilst dealing with the problems of operation, design and modification of the refinery plants. Candidates should have a good Degree, preferably in Chemical Engineering, with at least five years' experience of work carried out at a supervisory level in the petroleum or related industries, and a sound knowledge of refining operations. (b) Process Engineer, to head distillation section of the technical dept.; experience is required in the design and operating problems of distillation and hydrogenation units. (c) Process Engineer, to head lubricating oil section of the technical department; experience in the design and operating problems of lubricating oil processing plant is necessary. For vacancies (b) and (c) candidates should have a good scientific Degree, preferably in Chemical Engineering, with at least five years' experience of similar work carried out at a responsible level. (d) Assistant Chief Chemist: candidates should have a good Honours Degree in Chemistry with at least five years' experience of laboratory supervision of graduate and non-graduate staff engaged on quality control and plant research work related to the manufacture of a wide range of petroleum products. Candidates with experience in related industries will be considered. Non-supervisory posts: in a section of the foregoing, there are a limited number of vacancies with good prospects for Chemical Engineers. Candidates should have good Honours Degrees, and experience in the petroleum or allied industries would be an advantage. All the above posts are pensionable.—Applications, with full details of age, experience and salary requirements, should be sent to the Employee Relations Superintendent, Esso Petroleum Company, Ltd., Fawley, Southampton. E6730 A

ESTIMATOR required by company specialising in design and construction of petroleum and chemical plant. Applicants must be experienced in this particular field and able to work on own initiative.—Write, giving full details to Head Wrightson Processes, Ltd., 24-26, Baltic Street, London, E.C.1. E2578 A

ESTIMATOR required by large marine engineering firm on the Clyde, with experience of first-class marine diesel engine and steam turbine and boiler practice. Experience of welded pressure vessels and oil-refining plant also desirable.—Please apply in writing, giving age, full particulars of experience and salary required, to O5XO, Wm. Porteous and Co., Glasgow. E6761 A

EXCELLENT OPENINGS exist for Designer-Draughtsmen, possessing the necessary qualifications and initiative, in the drawing-office of a West Midlands works engaged in the production of I.C. engines transmission and industrial sets. A Higher National Certificate or equivalent is essential for the senior appointments. State experience and salary required.—BOX No. E2559, "The Engineer." A

EXPERIENCED DRAUGHTSMAN required in South-West London. Knowledge of refrigeration and food factory lay-out preferred, but not essential. Good conditions; five-day week. Must be capable of handling complete plants on own initiative.—State age, experience and salary required.—BOX No. E2600, "The Engineer." A

EXPERIENCED DRAUGHTSMEN and intelligent Junior Draughtsmen are required for permanent progressive positions in West End of London office of large industrial company and in South-West London branch. Chemical engineering experience useful, but not essential. Good technical education and training necessary. Five-day week, superannuation scheme, canteen.—BOX K4837, A.K. Advg., 212a, Shaftesbury Avenue, W.C.2. E6646 A

FOREMAN ENGINEER, also Manager, required for new reconditioning shop; sound knowledge I.C. engines and overhauling of general contractors' plant essential. Salary range £500 to £1000 per annum. House provided.—Fred Watkins, Sling Engineering Works, Coleford, Glos. E6741 A

FOREMAN required, to take charge of small iron and non-ferrous jobbing foundry in Bristol area. Write, giving particulars of experience and qualifications.—BOX No. E2556, "The Engineer." A

HANDLEY PAGE, LTD., have a vacancy for a Technical Assistant with a good mechanical engineering background, who will be required to carry out in connection with thermodynamic problems for aircraft air conditioning and thermal de-icing systems.—Write, stating age and giving particulars of qualifications and experience, to Staff Officer, Handley Page, Ltd., Claremont Road, London, N.W.2. E6558 A

GOOD OPPORTUNITY for Works Manager with drive and initiative to take charge of works departments engaged on aero-engine research and development. Applications are invited from men between 30 and 45 with previous experience on gas turbine and reciprocating engines. The position demands first-class experience in efficient operation of machine, sheet metal and assembly shops, as well as co-ordination of material supply, planning and jig and tool activities on urgent small batch manufacture. Details of qualifications and experience.—BOX No. E6626, "The Engineer." A

HAND TOOL MFRS. req. part-time services of Trav. already calling engr. wks., London, Home and Southern Counties. Commission.—BOX No. E2598, "The Engineer." A

HEATING AND VENTILATING Design Draughtsmen required by consulting engineers in London. Salary £550–£600 p.a. or above, according to ability.—BOX No. E6864, "The Engineer." A

JIG AND TOOL DRAUGHTSMEN (age 25–35) required by manufacturers of automobile and aircraft accessories in South Midlands. Practical experience in toolroom and production shops and good technical qualifications essential. Salary according to ability. Single accommodation available. State salary, age and full particulars.—BOX No. E6784, "The Engineer." A

JIG AND TOOL DRAUGHTSMAN required for light engineering firm. Experience in plastic moulds and press tools for precision components essential.—Apply in writing to Burgess Products Company, Ltd. (Micro Switch Division), Dukes Way, Team Valley, Gateshead, 11. E2534 A

JUNIOR CONTRACTS ENGINEER required by manufacturers of diesel-electric locomotives. Applicants should be between the ages of 22 and 30, with technical training to Graduate I.E.E. or I.Mech.E. standard, and preferably practical experience or an apprenticeship with manufacturers of diesel-electric traction equipment. The post will involve the commercial and general technical aspects of diesel-electric locomotives manufacture and it will be an advantage if applicants possess previous contracts experience of this nature. Excellent prospects for man with personality and ambition. Applications in confidence.—BOX No. E6817, "The Engineer." A

JUNIOR DRAUGHTSMEN required, S.E. London area, with experience of design and development of aircraft instrument mechanism.—Applicants should write, stating age, salary expected, with details of experience, to BOX E.661, at 191, Gresham House, E.C.2. E6830 A

KUWAIT OIL COMPANY requires Technical Instructors for Training Division in Kuwait as follows:—(a) Two Technical Instructors in general engineering fitting; (b) two Technical Instructors for motor mechanics; (c) one Technical Instructor for machine operators. All applicants must have full recognised mechanical engineering apprenticeships (in (b) garage apprenticeship will not qualify), Ordinary National Certificate and at least five years' experience as master tradesmen. Preference given to candidates with previous experience as instructors; age 32–40. Salary in all cases starting £710 per annum clear, plus generous allowances, pension scheme and kit allowance.—Write, giving personal details and quoting appropriate reference, (a) K.1429/1337, (b) K.1430/31, (c) K.1432, to BOX E/65 at 191, Gresham House, E.C.2. E6815 A

LADY TECHNOLOGIST or Graduate required for engineering test dept., S.E. London, to be responsible for technical records. Ability to undertake technical investigations under guidance; Knowledge of typing an advantage, but not essential. A Lady Engineering Student is also required.—Write, stating salary required, giving qualifications and previous experience, if any, to BOX E.651, at 191, Gresham House, E.C.2. E6755 A

LARGE ORGANISATION in Midlands has vacancies for Senior and Junior Body Draughtsmen. Experience in passenger car and commercial vehicle cab all-steel construction.—BOX No. E6819, "The Engineer." A

LAY-OUT ENGINEERS' DEPARTMENT of large engineering company in London area has progressive superannuated vacancy for an applicant who has the following qualifications:—Sound knowledge of building construction and ability to survey existing premises, prepare drawings in connection with alterations and extensions to industrial premises, experience in dealing with architects, builders and engineers, knowledge of structural engineering an advantage. Must be able to take complete charge of a project of work with the minimum of supervision. Good salary.—Full written details of past experience and qualifications to BOX K.514, A.K. Advg., 212a, Shaftesbury Avenue, W.C.2. E6793 A

LOCOMOTIVE, Carriage and Wagon Senior Draughtsman, 30/35 years of age. Qualifications: must have served a full general apprenticeship in an engineering workshop (preferably railway) and have had at least five years' drawing-office experience with some time in an executive capacity. A knowledge of Spanish an advantage. Future prospects.—Apply to the Secretary, Peruvian Corporation, Ltd., 144, Leadenhall Street, London, E.C.3. E455 A

MACHINE TOOL DESIGNER.—Position is available in West Midlands for a first-class Machine Tool Designer familiar with manufacture of press brakes, guillotines, sheet metal working machinery, &c., by steel fabrication methods. Applicant must have good knowledge and background of machine tool industry, and only those with wide experience capable of working on own initiative need apply.—BOX No. E2580, "The Engineer." A

MALE ESTIMATOR Rate Fixer required immediately. Must be experienced. Superannuation scheme in operation. Five-day week; canteen and sports facilities.—Apply in writing to Personnel Officer, Allen and Hanburys, Ltd., Bethnal Green, London, E.2. E6874 A

MANAGER WANTED for Middle East road surfacing contract. Must be experienced in organising, quarrying, producing and laying.—Apply, stating age, experience, salary required, Thos. W. Ward, Limited, Albion Works, Sheffield. E6752 A

MECHANICAL DETAIL DRAUGHTSMEN, age 20/30, with workshop experience. Minimum qualification O.N.C. or equivalent. — BOX No. E441, "The Engineer." A

MECHANICAL/ELECTRICAL Engineer required, aged 25–30. Applicants should have a good University Degree in Mechanical or Electrical Engineering. Alternatively, those having served a recognised apprenticeship with a reputable engineering firm will be considered. Such applicants should have technical qualifications to at least Higher National Certificate standard, and should be able to produce some evidence of having had responsibility for even minor installations. Knowledge of chemical engineering will be an advantage. The post carries sound prospects and is with a factory in the extreme East London area. Fullest information and salary required, marking the envelope for the attention of the Chief Engineer.—BOX No. E6822, "The Engineer." A

MECHANICAL ENGINEER, age around 25, with a Degree or Diploma, who has served a recognised apprenticeship and has had around two years' post-graduate industrial experience is required as a Technical Assistant in Edinburgh. The duties are varied and provide wide scope for initiative and high technical ability. The position is permanent and pensionable and the prospects are excellent. Reply, giving full details of education and experience.—BOX No. E6885, "The Engineer." A

MECHANICAL ENGINEERS required by large oil company for service overseas. Candidates must have (a) five years' apprenticeship and possess the Higher National Certificate in Mechanical Engineering, or (b) two years' practical experience with the following: (i) an Engineering Degree and/or (ii) be Graduates or Associate Members of the Institution of Mechanical Engineers. Candidates under category (a) age limit 23–28, under category (b) between ages 23–30; married men under 26 years of age will not be considered for either category. Initial contracts three to four years; commencing salary £620 p.a. upwards, according to age and qualifications; pension scheme benefits and local cost-of-living allowances; £85 outfit allowance; first-class passages provided. Excellent prospects of progressive career.—Apply in writing, giving age, with full particulars of education, qualifications and experience, to BOX Z.V.894, Deacon's Advertising, 36, Leadenhall Street, E.C.3. E435 A

MECHANICAL HANDLING ENGINEERS require Draughtsman with wide experience of bulk and package handling to take charge of drawing-office in Glasgow, must have wide technical and practical experience; house may be made available. Write, giving full details of experience, &c., and state age and salary expected.—BOX No. E2592, "The Engineer." A

METALLURGISTS required by the Bahrein Petroleum Co., Ltd. Permanency and opportunity for advancement for qualified men. Must have Bachelor's Degree in Metallurgy and several years' practical experience in the determination and cause of stress failures, analytical experience for identification of metals, scales and corrosion products. Commencing salary according to qualifications and experience, the company providing free board, air-conditioned living accommodation and medical attention. Other living costs are low. Agreements are for two-year period with paid local and home leaves. A kit allowance is made for initial tour and a pension scheme is in operation.—Write, with full particulars of qualifications, experience and salary required, to BOX 5243, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E107 A

OIL BURNER MANUFACTURERS in Surbiton, Surrey, require Two skilled Service Engineers for fully automatic oil burners, preferably with previous experience in oil burning. Must have good general mechanical and electrical knowledge and be prepared to travel to various sites in London area, Home Counties and other parts. Two Centre Lathe Turners, for Tolworth works. Good pay and allowances, pension scheme and overtime; also experienced Mechanical Draughtsmen.—Write, Combustions, Ltd., Cox Lane, Tolworth, Surbiton, Surrey, or telephone ELMbridge 7165. E2536 A

OUTSIDE SERVICE FITTER required by leading contractors' Plant manufacturers in South-West London. Must be thoroughly skilled, able to drive and experienced in hydraulically operated equipment.—Apply, BOX No. E2515, "The Engineer." A

PETER BROTHERHOOD, Ltd., Peterborough, require Draughtsmen (senior and junior), preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme.—Write, giving full details age, experience and salary required. E342 A

PIPEWORK DRAUGHTSMEN, Senior, experienced in estimates, design, high and low-pressure industrial pipework. East London and South Essex area. Bonus scheme; good opportunity for keen men.—BOX No. E2576, "The Engineer." A

PLANNING ENGINEER required for general engineering works engaged in reconditioning general plant; must be first-rate organiser with wide experience. Salary range £750 to £1000 per annum —Fred Watkins, Sling Engineering Works, Coleford, Glos. E6742 A

PLANNING ENGINEER required to take charge of planning and methods section of a Lincolnshire engineering company. Applicant should have had some experience of jig and tool practice and in modern production methods of medium and heavy engineering, and should preferably have held a similar position previously.—BOX No. E6882, "The Engineer." A

PLANT ENGINEER.—A vacancy exists for an experienced Engineer, to take full charge of the mechanical and electrical maintenance depts. of a general engineering establishment in Stockport. The position carries responsibility for the maintenance of machine tools, forge and boiler plant, heat-treatment furnaces, miscellaneous factory plant and equipment, and buildings. Previous experience in a similar responsible position essential. Apply, stating age, full details of previous experience and salary required.—BOX No. E466, "The Engineer."

PRESSURE DIE CASTING works, Birmingham area, have appointment for first-class man as Estimator and Planning Engineer. Applicants must be fully experienced in all classes of work, including manufacture of dies. Only fully competent men with drive and initiative need apply. Write in strictest confidence, with full particulars of age, experience, qualifications, and salary expected, to Technical Manager.—BOX No. E2584, "The Engineer." A

For continuation of Small Advts., page 6

SITUATIONS VACANT

PRODUCTION ENGINEERING Research Association invites applications from young men with a First or Second Class Honours Degree, Higher National Certificate or equivalent qualification in mechanical or production engineering for positions as Research Engineers. For successful applicants who can work on own initiative there are good prospects of advancement. Commencing salary commensurate with experience and qualifications; superannuation under F.S.S.U.—Applications to Secretary, Production Engineering Research Association, Melton Mowbray, Leics. E6836 ▲

PRODUCTION MANAGER required by large engineering company, London area, to be responsible for producing hydraulic servo mechanisms and other precision mechanical units. Exceptional opportunity for graduate engineer conversant with modern production methods and accustomed to controlling skilled personnel.—Write fully, stating age, education, particulars of posts held, and salary expected, to BOX E.653, at 191, Gresham House, E.C.2. E6779 ▲

PROGRESSIVE engineering company in the Manchester district invites applications for the following positions on their technical staff:—(1) An Engineer, to take charge of time study. This requires a technically trained engineer with experience in modern time study methods. (2) A Machine Shop Methods Engineer. This requires an engineer experienced in modern machine shop practice for the production of medium and small components in batch quantities. Applicants should state fully particulars of education, experience and commencing sal ry required.—BOX No. E2567, "The Engineer." ▲

QUALIFIED Mechanical/Electrical Engineer with commercial experience, executive and practical ability, required by old-established British engineering firm in Bangkok; age 25/35. Some knowledge of radio engineering desirable, but not essential. Salary according to qualifications and experience. Provident fund and excellent prospects. —BOX "DE/4," c/o 95, Bishopsgate, E.C.2. E6720 ▲

REINFORCED CONCRETE DESIGNERS and Draughtsmen required in consulting engineers office, for the design and detailing of structures and foundations in connection with steam generating stations, tunnel, harbour, hydro-electric and other works. Salary according to qualifications and experience.—Applications, with references to previous employers, to Sir William Halcrow and Partners, MM.I.C.E., Alliance House, Caxton Street, Westminster, S.W.1. E6876 ▲

REQUIRED, Engineering Draughtsman, fully conversant with colliery engineering plant and preparation of lay-out, general arrangement and detail working drawings of such plant. Salary in range £453–£573 p.a., according to experience and qualifications; house available.—Applications, stating age, qualifications, training and experience, to Area General Manager, No. 4 Area, National Coal Board, Bankfield, Workington, Cumberland. E6814 ▲

SENIOR DESIGNER DRAUGHTSMAN required, S.E. London area, with experience of design and development of aircraft instrument mechanism.—Applicants should write, stating age and salary expected, with details of experience, to BOX E.660, at 191, Gresham House, E.C.2. E6831 ▲

SENIOR DRAUGHTSMAN required. Applicants should have had several years' drawing-office experience and should be Corporate Members of the Institution of Mechanical Engineers or hold the Higher National Certificate in Mechanical Engineering. Plant lay-out and general design work is essential and experience in paper or allied trades is desirable.—Applications in writing, giving details of experience and salary required, should be made to the Chief Engineer, The Bowater Paper Corporation, Limited, Northfleet, Kent. E2544 ▲

SENIOR DRAUGHTSMAN required with experience in light engineering and sheet metal work. Superannuation scheme in operation. Five-day week; canteen and sports facilities available.—Apply in writing, giving details of experience and salary required, to Personnel Officer, Allen and Hanburys, Ltd., Bethnal Green, E.2. E6875 ▲

SENIOR DRAUGHTSMAN required by large engineering works in the Manchester area, with experience in the design and detailing of the following types of work:—Mechanical engineering, general equipment of medium character; plant office work, on lay-outs and production tooling. Salary in excess of A.E.S.D. rates. Good prospects for suitable applicant.—BOX No. E2591, "The Engineer." ▲

SENIOR DRAUGHTSMAN required for development work special purpose machines, light and medium heavy. Applicant must be capable of complete design from engineers' data and sketches. Knowledge of glass an advantage. Minimum salary A.E.S.D. Excellent opportunity for right man.—BOX No. E436. "The Engineer." ▲

SENIOR DRAUGHTSMAN, trained and experienced to H.N.C. standard in heavy engineering industry. Estimating experience an advantage. Good salary, comfortable office in Lancashire. Reply, stating details of education and experience in chronological order.—BOX No. E6866, "The Engineer." ▲

SENIOR DRAUGHTSMEN required in Manchester, 25 years of age and upwards, experienced in the design and detail of mechanical handling plant and structural steelwork. General engineering training to H.N.C. standard preferred. Good salary. Production bonus in operation.—Apply to "E" Department, West's Gas Improvement Co., Ltd., Albion Ironworks, Miles Platting, Manchester, 10. E138 ▲

SENIOR PRODUCTION ENGINEER required for light engineering factory engaged on piecepart production on small quantity basis. The factory is in the North of England and some previous experience in this area is essential. Applicants must have first-class experience which demonstrates their ability to operate without detailed guidance. Write, stating age, education, detailed machine experience, and salary required.—BOX No. E2582, "The Engineer." ▲

SERVICE ENGINEER, preferably with automatic combustion control experience, required. Age about 35, with sound technical training. H.Q., London district. Salary according to experience.—BOX No. E2545, "The Engineer." ▲

SPECIAL-PURPOSE Machine Designers and Jig and Tool Designers required by engineering consultants in London. Salary £550–£600 p.a. or above according to ability.—BOX No. E6863, "The Engineer." ▲

SPERRY GYROSCOPE CO., LTD., Great West Road, Brentford, Middlesex, require Senior Draughtsmen, (a) electronics, and (b) with precision electro-mechanical experience; Junior Draughtsmen, for detail and assembly work.—Write, with full details, age and salary required, to the Personnel Manager. E399 ▲

STRUCTURAL STEELWORK detail Draughtsmen required in Manchester. Good salary; production bonus in operation.—Apply to "E" Department, West's Gas Improvement Co., Ltd., Albion Ironworks, Miles Platting, Manchester, 10. E147 ▲

STRUCTURAL STEELWORK Draughtsmen required for London, Manchester, Northwich and Chester. Applicants should be experienced in the detailing of all types of steel structures, with the minimum of supervision.—Write, stating experience, age and salary required, to Joseph Parks and Son, Ltd., 12, Buckingham Palace Road, S.W.1. E2603 ▲

SUPERINTENDENT required for pressure die-casting works, Birmingham area. Excellent prospects for right man. Applicants must be good organisers, experienced in co-ordination of drawing-office, tool room and casting shop. Only first-class men with drive, initiative and energy need apply. Write in strictest confidence, giving full particulars of education, previous experience and salary required, to Technical Manager.—BOX No. E2579, "The Engineer." ▲

TECHNICAL ARTIST required by engineering firm in Acton, for line and tone, airbrush experience preferred. Experience of engineering work for catalogues, manuals, &c., essential. Five-day week. State age, experience and salary required.—BOX No. E6833, "The Engineer." ▲

TECHNICAL ASSISTANT required for engineering director of well-known Clydeside firm of auxiliary machinery makers. Applicants should have Degree or equivalent educational standard with requisite practical experience. They should preferably possess design experience on steam turbines, feed systems, and heat exchange apparatus for land and marine power installations. State salary required. Pension scheme and assistance given on house purchase.—BOX No. E6867, "The Engineer." ▲

TECHNICAL ASSISTANT required for weight control office. Ordinary or Higher National Certificate preferred, knowledge of engine stress calculations desirable.—Please write, stating age and giving previous experience in chronological order, to The Personnel Officer, The de Havilland Engine Co., Ltd., Stag Lane, Edgware, Middlesex. E6721 ▲

TECHNICAL WRITER required, preferably with experience of refrigeration applications; however, considerations will be given to a man with considerable ability outside the refrigeration industry. Permanent appointment. Please write in confidence, furnishing fullest details of training and experience, also stating age and salary required.—BOX No. E2577, "The Engineer." ▲

TECHNOLOGISTS, Mechanical Engineers, Higher National Certificate or Graduates, 20–30 years, required for permanent appointments mechanical test dept., S.E. London. Must be capable of undertaking investigations into performance and analysing of test results of electro-mechanical, mechanical and hydraulic mechanisms. Some test gear design from specification data and routine testing involved.—Write, stating salary required, giving qualifications and previous experience, to BOX E.652, at 191, Gresham House, E.C.2. E6754 ▲

THE DE HAVILLAND AIRCRAFT Company, Ltd., offer unusual facilities for advancement to Senior, Intermediate and Junior Draughtsmen for design and detailing of aircraft components at their Hatfield and London offices. High rates of pay, a superannuation scheme, comprehensive sports facilities, an art society, and excellent working conditions are all available to first-class men.—Apply, stating age, experience and salary required, to the Chief Draughtsman, The de Havilland Aircraft Company, Ltd., Hatfield, Hertfordshire. E440 ▲

THE ENGINEER BUYERS and Representatives' Association (Limited by Guarantee). The Council of this dominant, non-profit professional organisation is open to fill vacancies for Engineer Buyers and Engineer Representatives (no fees—employers or members) and to consider applications for membership from the more responsible qualified buyers and representatives associated with the engineering and allied trades.—Write, General Secretary, Engineer Buyers and Representatives' Association, Ltd., 47, Victoria Street, London, S.W.1 (Tel., ABB 3583). (Employment Section: Licence No. 6063—Licensed annually by the L.C.C.). E108 ▲

THE KUWAIT OIL COMPANY invites applications from Chartered Civil Engineers who have had wide experience with local public authorities or contractors, for immediate appointment in Kuwait, Persian Gulf. Experience should include building construction, structural steelwork, roadwork, water supply, sewage and executive positions of responsibility, such as agent in charge or resident engineer on major works for three years or more. Salary £1500 p.a. clear, plus generous living allowances. Pension scheme, kit allowance. Age 35 to 45.—Write, giving details and quoting K.1166, to BOX D/15, at 191, Gresham House, E.C.2. E6572 ▲

TWO REINFORCED CONCRETE Draughtsmen wanted, fully experienced in the design of R.C. structures, foundations and other civil work. Excellent prospects and salaries for men with initiative, required by old-established Tees-side firm. Accommodation arranged. Apply, sending full particulars and quoting reference D.O.—BOX No. E6850, "The Engineer." ▲

TWO SECTION LEADER Structural Draughtsmen wanted for Tees-side, capable of designing steel-framed buildings, structures, trestling, pipe bridges, &c., in conjunction with blast-furnace and other heavy engineering and chemical plant. Salary £600 upwards, according ability. Detailers also required. Accommodation arranged. Apply, stating full particulars and quoting reference D.O. —BOX No. E6848, "The Engineer." ▲

TIME STUDY ENGINEER (25–35) required, West Middlesex light engineering company, to study and apply modern forms of incentive schemes in general use in light engineering industry; canteen; superannuation. Full details and salary required.—BOX No. E2593, "The Engineer." ▲

TRACTION MOTOR DRAUGHTSMEN and Designer Draughtsmen required by manufacturers of diesel-electric locomotives. A sound knowledge of the mechanical as well as the electrical design of traction motors is essential, and applicants should have a wide experience of modern design and production methods in this class of work. Good salaries will be paid to men having these qualifications and special consideration will be given to other problems connected with the engagement of senior staff. Three years' agreement and every facility to find suitable living accommodation will be given. Please apply, giving full details of training, experience, age, &c.—BOX No. E6839, "The Engineer." ▲

TWO DRAUGHTSMEN are urgently required by engineering firm of repute in the North-West district for plant maintenance work. Applicants must have good knowledge of I.C. engine test equipment, also be capable of carrying out designs on their own initiative. Salary according to age and experience.—BOX No. E6801, "The Engineer." ▲

TWO LEADING ELECTRICAL Draughtsmen or Designers required for Tees-side, experienced in design, lay-out and installation of complete electrical equipment for gas, chemical and blast-furnace plants. Excellent prospects for experienced men. Accommodation arranged. Apply, sending full particulars and quoting reference D.O.—BOX No. E6851, "The Engineer." ▲

TWO SECTION LEADER Draughtsmen wanted, experienced in the lay-out and design of gas, chemical, oil refining, and similar speciality plant. Applicants should have sound knowledge of mechanical design, pressure vessels, instrumentation, &c. Salary £600 upwards, according to qualifications and experience, offered by old-established continuously expanding company on Tees-side. Position also available competent detailers. Accommodation arranged. Apply, giving complete particulars and quoting reference D.O.—BOX No. E6849, "The Engineer." ▲

VENESTA, LIMITED, require an Assistant Engineer for their factory engaged in production of collapsible tubes (for toothpaste, shaving cream, &c.), and similar impact extrusions. The successful candidate will be responsible to the chief engineer for the maintenance of plant and machinery. Applicants should not be over 40 years of age, have served a good engineering apprenticeship and possess the Higher National Certificate. Experience of the control of labour and the installation of plant and machinery is essential. The commencing salary will be between £650 and £700 per annum.—Applications should be addressed to the Personnel Manager, Venesta, Limited, Silvertown, London, E.16. E6872 ▲

WANTED.—General Engineering Draughtsman. Accustomed to steel works plant but not essential. Developing company. Good prospects to suitable applicant. Superannuation scheme in operation. Please state age and salary required.—Apply. Managing Director, B. Thornton, Ltd., Turnbridge, Huddersfield. E2516 ▲

WANTED IMMEDIATELY, qualified Assistant Road Engineer for contract in Middle East, preferably with experience modern road-making in tropics. Salary £1250 per annum; food and accommodation free.—Apply, stating age and experience, Thos. W. Ward, Limited, Albion Works, Sheffield. E6751 ▲

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For continuation of Small Advts., page 8

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5-Ton Coles/Thornycroft Road Mobile Crane, 6 by 4 chassis, series VII, Mark 2, petrol engine driven.
4-Ton Link Belt, All-round Slewing Road Mobile Crane, petrol engine driven, solid rubber tyres.
Jones 12-Cwt. Portable Crane, 18ft. jib, steel wheels, petrol engine driven.

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CURVED TYPE STEEL-FRAME BUILDING overall size 40ft. span by 100ft. long by 19ft. to centre, large industrial type sliding doors in each end with windows either side. Building delivered complete with all the necessary sheeting and fixing accessories to your prepared site. Price and details on request.—ALL PURPOSE BUILDING CO., Ltd., Chilton, Sudbury, Suffolk. Telephone, Sudbury 2924–6. Dept. VH/DM/E. E6854 G

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FOR PROMPT DELIVERY

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ROWLAND 16in. Swing Frame Grinder, motor drive, wheel 16in. by 2½in., grinding wheel bore 6in.

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SOAG MACHINE TOOLS, LTD.,
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'Phone : RELiance 3373 (5 lines).
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(1) 32,000 lb. per hour Thornycroft, self-contained, three-drum type Water-Tube Boiler, unused, 250 lb. working pressure, complete with a full set of new fittings and mountings, arranged for oil firing.
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Virtually unused Allis Chalmers H.D.14, H.D.10 and H.D. 7 diesel engine driven crawler Tractors with Dozers and Winches, immediately available ex stock.
BOX No. E465, "The Engineer." G

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"KEARNS" No. 4 Motor-Driven All-Geared, Boring, Facing, Milling and Drilling Machine, main table 60in. by 36in., top table 36in. by 36in., 32in. dia. facing head to face and edge up to 48in. dia., 10 H.P. motor drive, 440 volts, three-phase, 50 cycles.

"PEARN RICHARDS" No. 4, All-Geared, Motor-Driven Horizontal Boring, Facing, Milling and Drilling Machine, facing head 36in. dia., main table 60in. by 36in., top revolving table 36in. by 36in., 61in. longitudinal traverse, max. distance facing head to outer bearing support 8ft., quick power traverse in all directions.

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4000-ton Downstroke Hydraulic Press, by John Shaw and Sons, table 7ft. by 4ft.
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200 AIR RECEIVERS stocked, including three 24ft. by 4ft. 6in. by 150 lb.; twenty, 7ft. by 3ft. 4in. by 100 lb.; all tested and guaranteed.
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STEEL PIPING. — 10,000ft., 3in. and 6in. screwed ; 10,000ft. each 2in., 4in. and 6in. Victaulic ; 500 steel bends, 6in., 8in. and 10in.
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FOR SALE

600

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904 c.f.m. SULLIVAN, two stage, angle type, water cooled, double acting, speed 257 r.p.m., W.P. 100 lb. continuous pressure, will operate at 125 lb., fitted intercooler, belt driven from 225-h.p. S/R induction motor, by E.C.C., 400/3/50.
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Four 500 c.f.m., 100/120 lb. Pressure Units, each comprising two-stage, water-cooled Sullivan compressor, direct coupled to Ruston 110/124-h.p. horiz. diesel engine, complete with ancillary equipment and spares, units maintained in first-class condition and can be inspected running on site.

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Inquiries to ALAN. R. DAVIES, Clyde Lane, Bristol, 6 (Telephones, 37018/9). E398 G

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Engines and Generators for disposal from stock of plant manufacturer. All new as received from makers and surplus as result of changes in production programme.
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Also available, 20 Scammell Engines, ex fire pumps, as new.
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Maximum honing diameter 6¼in.
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(1) 5000kW B.T.H. Turbo-Alternator Set, new 1922, 350 lb. working pressure, 750 deg. F. tem 3000 r.p.m., direct coupled to a 5000kW B.T.H. Alternator, 11,000 volts, three-phase, 50 cycles, 3000 r.p.m., complete with surface condenser, electrically driven water circulating pump, condensate extraction pump, oil pump, oil tank and cooler, all necessary valves, gauges, piping and spares.
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27/22 cu. ft. single chain Sand and Gravel Grab
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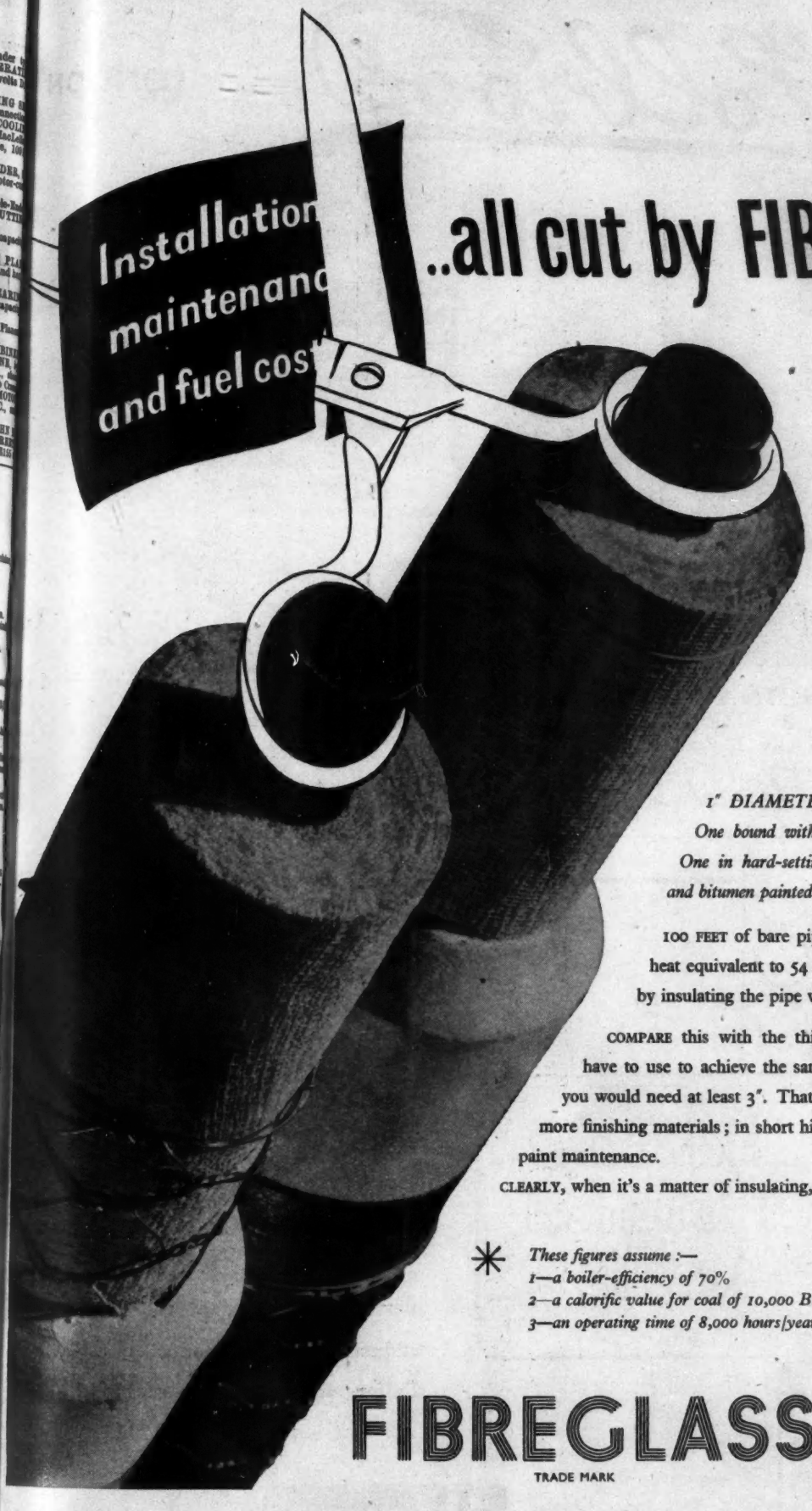
Inquiries to :—

ABELSON & CO. (ENGINEERS), LTD.

Coventry Road, Sheldon, Birmingham. Tel.: Sheldon 2424. E461

For continuation of Small Advts., page 10



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For structural, heat and cold insulation. Sound-deadening. Acoustic correction. Porous membranes for pipe wrapping, flooring, roofing. Battery retainers and air filters. In textile form for electrical insulation and flameproof decorative fabrics.

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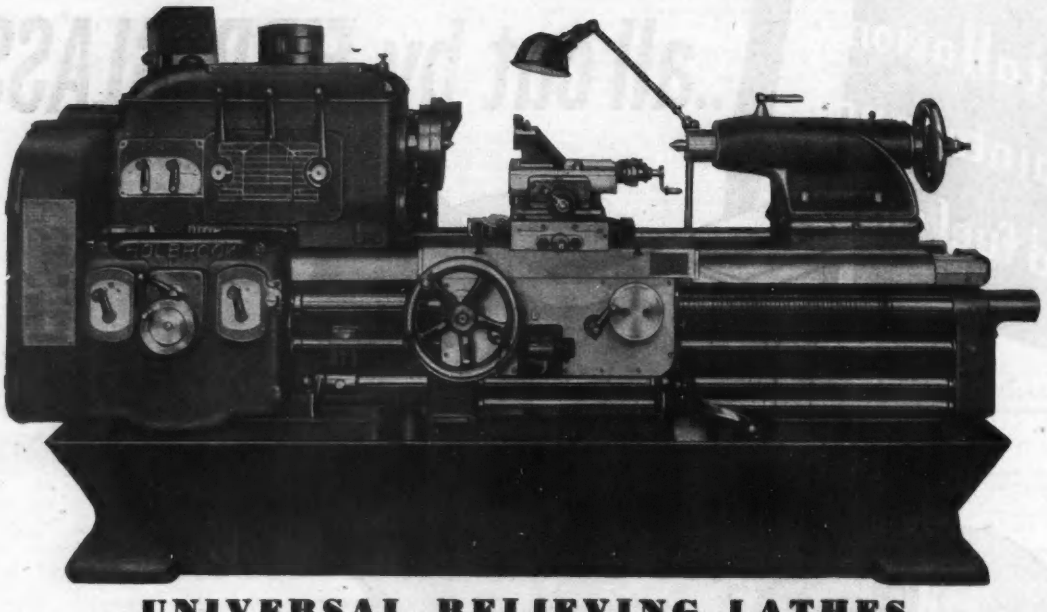

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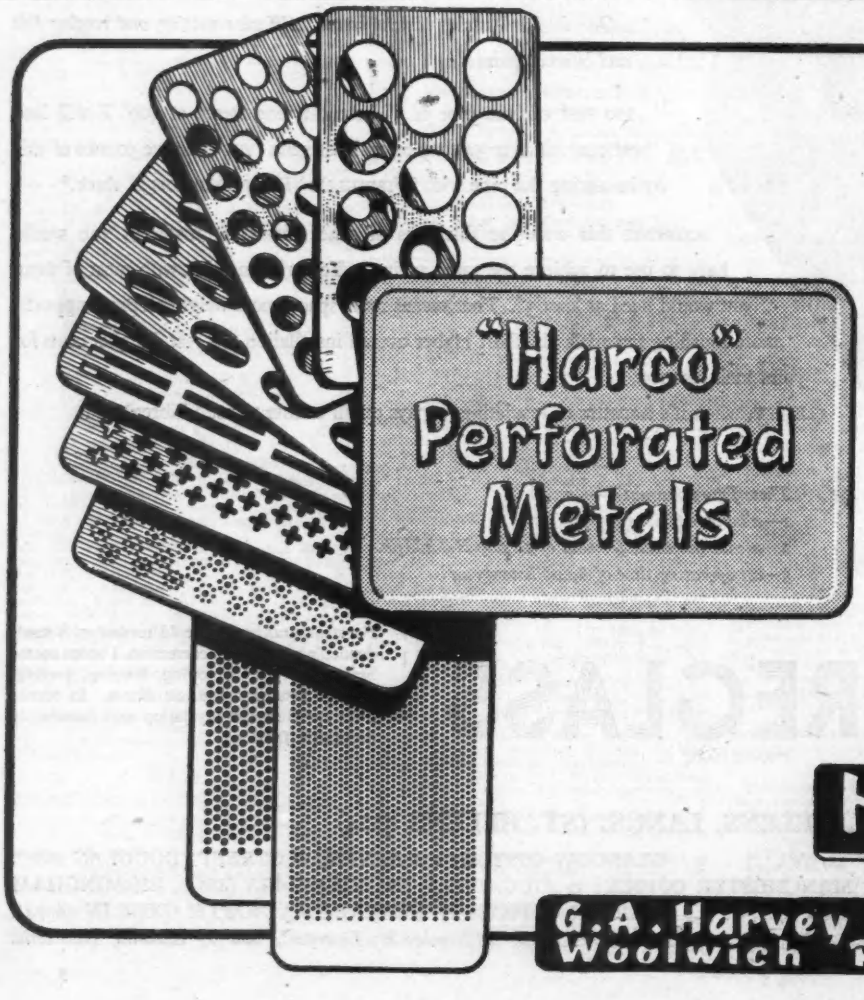

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FOR DISPOSAL

A.C. MOTORS

200/440 volts, 3-phase, 50 cycles.

No.	H.P.	R.P.M.	Rotor.	Type.	Bearings.	Maker.	Comments.
1	200	415	S.C.	Prot.	B.L.	G.E.C.	With controller and resistances (breaker can be supplied, if desired)
1	75	725	S.C.	Prot.	B.L.	Holmes	
1	70	735	S.R.	Prot.	B.B.	E.E.C.	With starter and rail.
1	55	1460	S.R.	Prot.	B.B.	C. Parkinson	With starter
1	30	960	S.C.	Prot.	B.B.	C. Parkinson	
1	30	960	S.C.	Prot.	B.B.	E.E.C.	
1	30	715	S.C.	Prot.	B.B.	E.E.C.	With starter
1	27½	725	S.C.	Prot.	B.B.	E.E.C.	With starter
1	25	970	S.R.	T.E.	B.B.	Higgs	With rails
1	25	730	S.C.	Prot.	B.B.	C. Parkinson	With starter
1	20	1445	S.R.	D.P.	B.B.	E.E.C.	With starter. Unused
1	20	1445	S.R.	D.P.	B.B.	E.E.C.	Unused, with new starter
1	20	1430	S.R.	Prot.	B.B.	Harland	Unused, with new starer
1	20	960	S.C.	Prot.	B.B.	Veritys	
1	18	1450	S.C.	Prot.	B.B.	G.E.C.	With starter
1	17½	960	S.C.	F.V.	B.B.	Higgs	With starter
1	15	725	S.C.	Prot.	B.B.	C. Parkinson	
1	15	950	S.C.	Prot.	B.B.	Veritys	With starter
1	15	950	S.C.	Prot.	B.B.	L.S.E.	
1	12	955	S.C.	Prot.	B.B.	Veritys	With starter
1	10	960	S.C.	Prot.	B.B.	Brook	
1	10	1440	S.C.	Prot.	B.B.	L.S. & B.	
1	10	950	S.C.	Prot.	B.B.	Veritys	With starter
1	10	702	S.R.	Prot.	B.B.	E.C.C.	With Brookhirst panel
1	10	960	S.C.	Prot.	B.B.	Veritys	With starter
1	7½	960	S.R.	Prot.	B.B.	G.E.C.	With starter. NEW
1	6	960	S.C.	T.E.F.C.	B.B.	Veritys	NEW
1	5	960	S.C.	Prot.	B.B.	E.E.C.	With starter
1	5	1400	S.C.	T.E.F.C.	B.B.	N.E.C.O.	NEW
1	4	950	S.C.	Prot.	B.B.	Veritys	With starter
1	3½	950	S.C.	Prot.	B.B.	Veritys	With starter
1	1½	950	S.C.	Prot.	B.B.	Met.-Vic.	
1	1	1500	S.C.	Prot.	B.B.	Brook	
1	¼	1450	S.C.	Prot.	B.B.	Higgs	
1	15/7½	945/478	S.C.	Prot.	B.B.	L.D.C.	Pole changing
1	1	31	S.C.	Prot.	B.B.	M. & Platt	With gearbox, vertical up output shaft

ONE RECONDITIONED 3/1 H.P. A.C. VARIABLE-SPEED COMMUTATOR TYPE MOTOR, by B.T.H., protected type, 400/440 volts, 3-phase, 50 cycles, 1830/610 r.p.m. Four pole, ball bearings, with hand-operated induction regulator by B.T.H.

230 volts, single phase, 50 cycles.

No.	H.P.	R.P.M.	Rotor.	Enc.	Bearings.	Maker.	Comments.
1	6	580	S.R.	Prot.	B.B.	B.T.H.	Split phase with starter, 460 volts
1	2	3000	S.C.	F.L.P.	B.B.	Brook	Split phase
1	¼	1425	S.C.	Prot.	Sleeve	E.E.C.	Split phase. NEW
1	¼	2800/50	R.I.	Prot.	B.B.	N.E.C.O.	Geared
1	2	100	R.I.	D.P.	B.B.	N.E.C.O.	Geared. NEW

NEW SINGLE SPEED GEARED MOTORS

TOTALLY ENCLOSED OR DRIP-PROOF ENCLOSURE.
SUITABLE FOR OPERATION OFF A: 400/440 volts, three-phase, 50 cycles supply.
100/250 volts, three-phase, 50 cycles.
100/250 volts D.C., shunt compound or series wound.

HORSE-POWER AVAILABLE: ¼, ⅓, ½, 1, 1½ and 2 H.P.
FINAL SPEED AVAILABLE: 480, 436, 406, 362, 350, 300, 280, 262, 245, 235, 220, 210, 200, 175, 156, 150, 125, 117, 110, 100, 88, 80, 75, 70, 64, 61, 53, 50, 44, 39, 34, 30, 29 and 26 r.p.m.

Also low range of speeds between ¼ and 15 r.p.m. at 100ft.-lb. torque and from 0.37 to 9.3 r.p.m. at 200ft.-lb. torque, 0.47 to 13 r.p.m. output at 800ft.-lb. torque, and up to 7 r.p.m. at 1500ft.-lb. torque.
Delivery on these units to be advised upon application. SMALL NUMBER OF UNITS AVAILABLE FROM STOCK FROM TIME TO TIME.

D.C. MOTORS

No.	H.P.	Volts.	R.P.M.	Type.	Winding	Maker	Bearings.
1	30	400	750	Prot.	Shunt	Higgs	B.B.
1	30	440	500/1000	Prot.	Comp.	M. & Platt	B.B.
1	30	440	765	Prot.	Shunt	Higgs	B.B.
1	15	440	1600	D.P.	Shunt	Veritys	B.B.
1	14	440	800	Prot.	Shunt	Higgs	B.B.
1	8	440	1900	Prot.	Shunt	Newton	B.B.
1	6	220	675	Prot.	Comp.	Hall	B.B.
1	46	230	650	Prot.	Shunt	E.E.C.	Sleeve with starter
1	30	220	500	Prot.	Comp.	B.E.P.	Sleeve
1	22	220	1150	Prot.	Comp.	Electro	Sleeve
1	10	220	1100	Prot.	Shunt	Veritys	Sleeve
1	13	220	945	Prot.	Comp.	G.E.C.	B.B.
1	5	220	1000	T.E.	Shunt	L.S. & B.	B.B.
1	3	220	1200	T.E.	Shunt	Veritys	Sleeve
2	24	110	1300	D.P.	Comp.	Harland	B.B.
1	13	110	645	Prot.	Shunt	Newtons	Sleeve
1	6½	110	1620	Prot.	Comp.	G.E.C.	B.B.
1	6	110	1620	Prot.	Comp.	C. Parkinson	B.B.
1	5	110	1620	Prot.	Comp.	G.E.C.	B.B.
1	5	110	990	Prot.	Comp.	G.E.C.	B.B.

MISCELLANEOUS

ONE RECONDITIONED 36kW, 220/300 volts, D.C., DIESEL ENGINE DRIVEN GENERATING SET, comprising Harland compound-wound, 1350 r.p.m. generator, direct coupled to Paxman-Ricardo vertical four-cylinder, type 4.RQ engine, mounted on bed-plate and complete with switchboard.
TWO AIR BREAK PUSH-BUTTON AUTOMATIC STAR DELTA STARTERS, by B.T.H. 5 H.P., 400/440 volts, three-phase, 50 cycles.
SEVEN HAND-OPERATED, OIL-IMMERSED STAR DELTA STARTERS, by Ellison, 7½ H.P. 400/440 volts, three-phase, 50 cycles.
FIFTEEN HAND-OPERATED, OIL-IMMERSED STAR DELTA STARTERS, by Erskine Heap, 30 H.P., 400/440 volts, three-phase, 50 cycles.
ONE AUTOMATIC CONTACTOR STATOR and ROTOR STARTER, by E.A.C., 16 H.P., 400/440 volts, three-phase, 50 cycles, rotor volts 320, rotor amps. 23.
ONE STATOR and ROTOR STARTER, with circuit breaker, by Ellison, and air break rotor regulator, by G.E.C., for varying the speed, 37 H.P., 400/440 volts, three-phase, 50 cycles, rotor volts 246, rotor amps. 77.
If the electrical equipment you need is not listed, please let us have details of your requirements, as the above is an abbreviated list only of the very large stock held of A.C. and D.C. motors, D.C. generators, A.C. and D.C. starters, and various other equipment.

FULL PARTICULARS AND PRICES ON APPLICATION **MECHANICAL STOCKLIST ON APPLICATION**

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Barimar SHORTENED this crippled Crankshaft

A Notable Response to "Second Thoughts" All the way from Poona

It is a Barimar characteristic to wrestle with the unusual; to grapple with the "out-of-the-ordinary" without turning a hair!

There came to Fulham from far-away Poona, the severed crankshaft of an eight-cylinder oil engine—it had snapped like a stick of celery and the owners decided that Barimar welding would not only avoid a hefty outlay for a new shaft, but precious time, likewise, was certain to be saved.

Severed Crankshaft of 8-cyl. oil engine from Poona.

Crankshaft repaired and converted for 4-cyl. engine. A Barimar Guaranteed job.

So the crippled crankshaft was sent to Bombay, and from there, shipped to England. Hardly was the job under way when the owners decided to have the crankshaft converted for use in a four-cylinder engine. Was this feasible? This was the cabled enquiry. Barimar replied that it was, and thereupon shortened the shaft as well as repaired it, welding it "well and truly." The pictures illustrate first the shaft as received and then repaired and shortened as shipped by Barimar. A job which merited the owners' bouquets, for not only did it represent a fine feat of engineering—it was also returned ready for immediate assembling, perfectly aligned with all crank pins and webs in the right relative positions.

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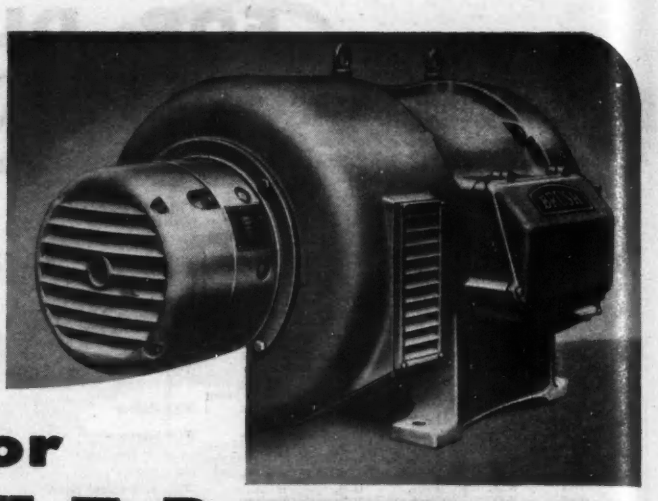
THE WORLD'S SCIENTIFIC WELDERS



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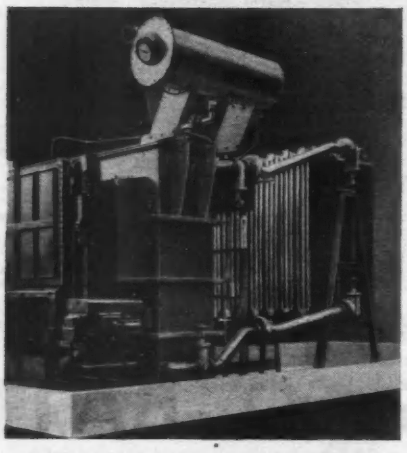

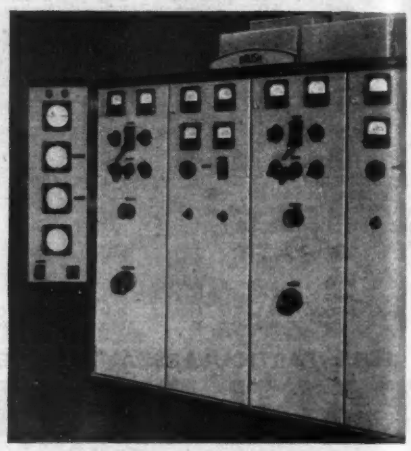

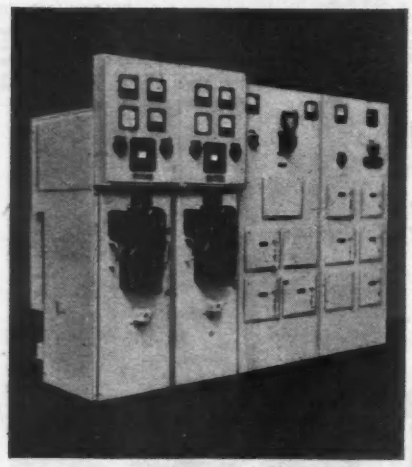

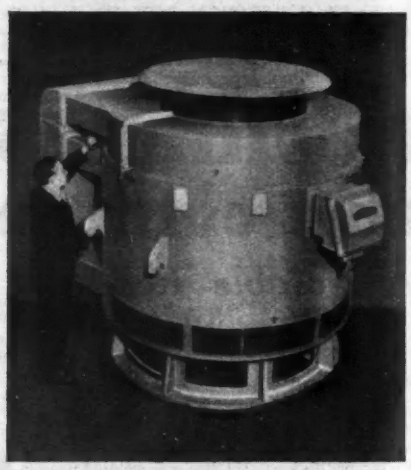

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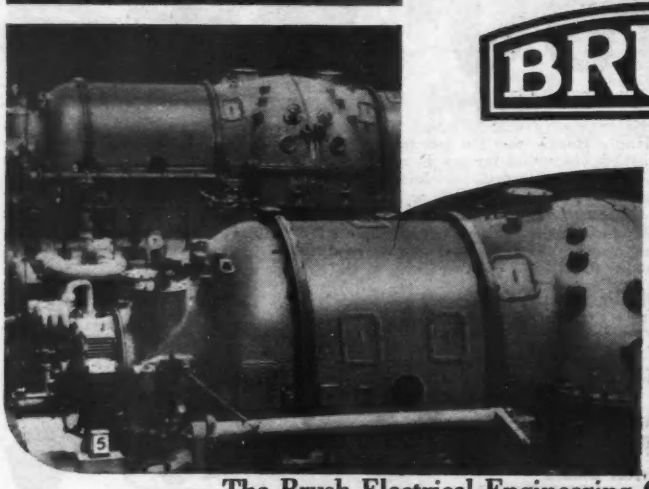

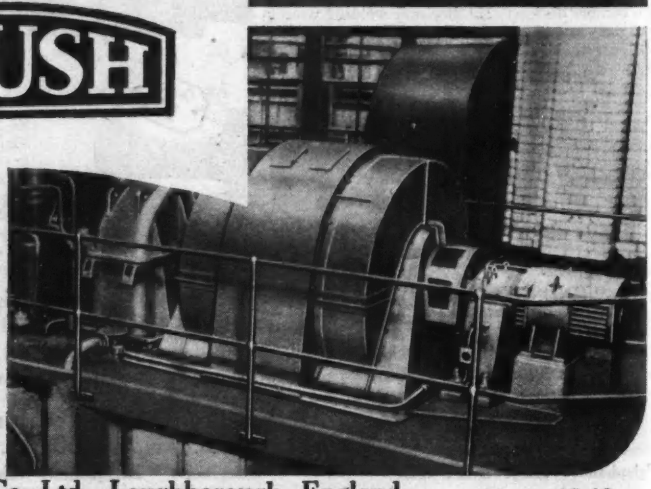

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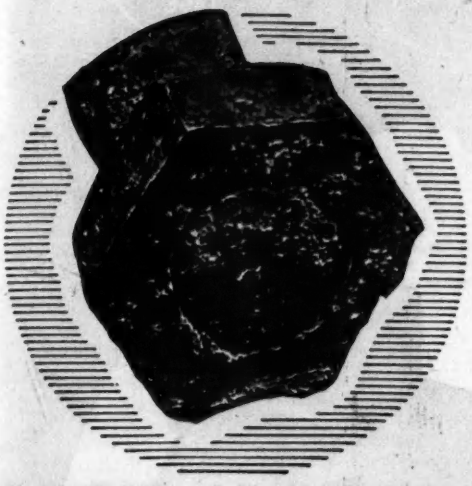

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Fraser No. 5 Vertical Drum Type Water-Tube Boiler, 1000 lb. evap., 100 lb. w.p.
Ruston Vertical Cross-Tube Boiler, 650/750 lb. evap., 100 lb. w.p.
Spencer Hopwood No. 4 Vertical Multitubular Boiler, 450/650 lb. evap., 100 lb. w.p.
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12½-kVA, 400/3/50, 4-wire, A.C. Alternator Set, Lister Diesel Engine, Mawdsley Alternator, rad. cooled, skid mounted.
50-kVA, 400/3/50, 4-wire, A.C. Alternator Set, A.E.C. 7·7 litre Diesel Engine, rad. cooled, skid mounted.
85-kVA, 415/3/50, A.C., 4-wire Alternator Set, Blackstone Horizontal Diesel Engine, Westinghouse Alternator with switchboard controls.
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VERTICAL DIESEL OIL ENGINES

600 b.h.p. Ruston and Hornsby 6-cyl., type 6VER, speed 300 r.p.m.
440 b.h.p. Ruston and Hornsby 8-cyl., type 8VER, speed 428 r.p.m.
400 b.h.p. Harland and Wolff Vertical Type TR4, marine, speed 300 r.p.m.
100 b.h.p. Ruston and Hornsby Vertical Model, Type 2VE, Diesel Oil Engine, speed 310 r.p.m.
30 b.h.p. Blackstone Vert. 3-cyl., Diesel Oil Engine, speed 1000 r.p.m.
UNUSED.—78 b.h.p. Blackstone Twin-Cyl., Model EPV2, 600 r.p.m., Vert. Cold-Start Diesel Engines with out-end bearing shaft extension, Air Compressor and Receiver Pumps.

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Weir Vertical Steam Boiler Feed Pump, 4in. by 6in. by 7in., 2in. suction, 1½in. delivery, 660/810 gal./hr.
Tangye Vertical, Three-Throw Pump, plungers 6in. dia. by 8in. stroke, 8800 gal./hr. at 240 r.p.m.
Weise Horizontal Duplex Boiler Feed Pumps, 4½in. by 2¾in. by 4in., 650 gal./hr.
Bradley and Turton Vertical Three-Throw Hydraulic Pump, plungers 1½in. by 4in. stroke, 2·8 gal./min. at 3000 lb. w.p.
Stothert and Pitt Screw Displacement Pumps (for Benzole), 80/85 gal./min. at 50ft. head, Flameproof Motor.

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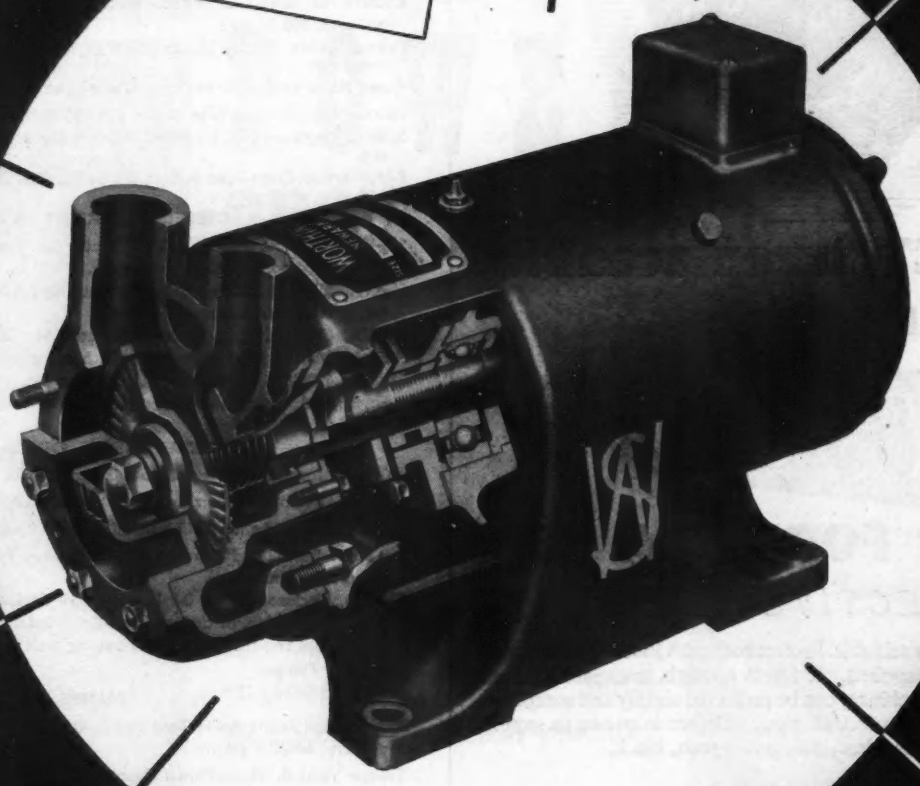

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Capacities up to 1800 G.P.H. with heads up to 300 feet, depending on capacity.

Vortex Pumps employ the most modern principles of regeneration by which a multi-vaned impeller engages and re-engages the liquid pumped to develop high heads efficiently in a single stage. Having a steep characteristic they are readily adapted to wide variations of head with little change in capacity, and—contrary to most small centrifugal pump characteristics—if they are selected for the maximum head condition, no overload of the driver is possible at lower heads as the power required decreases as the head decreases.

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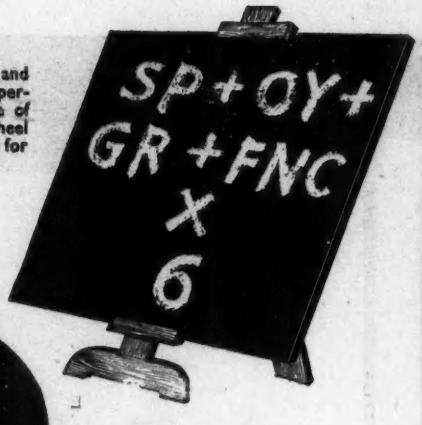

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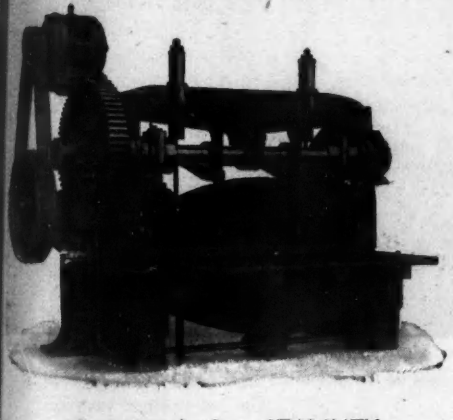

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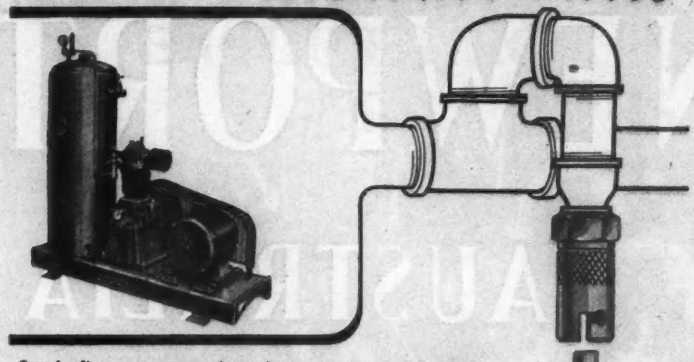

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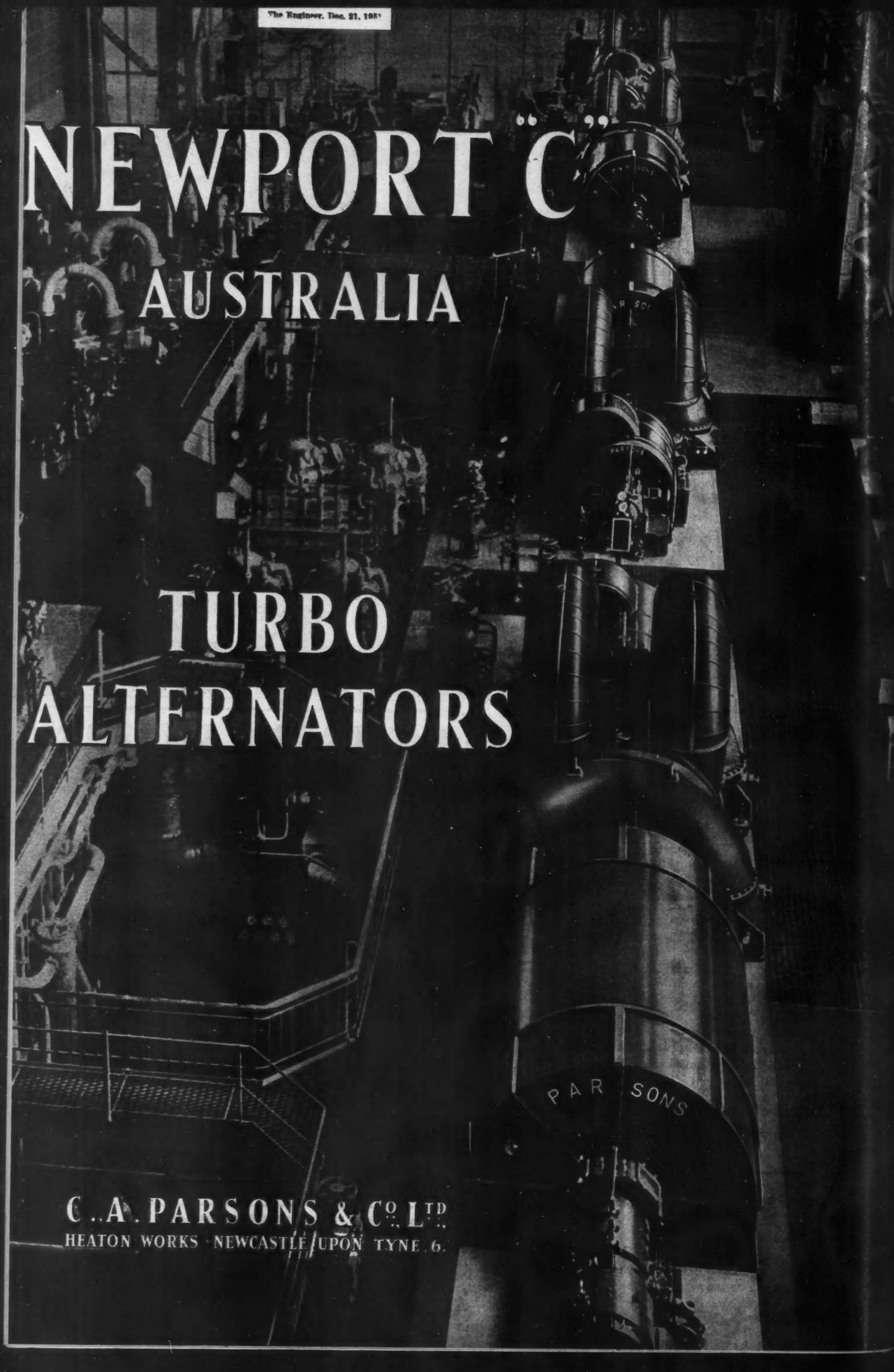
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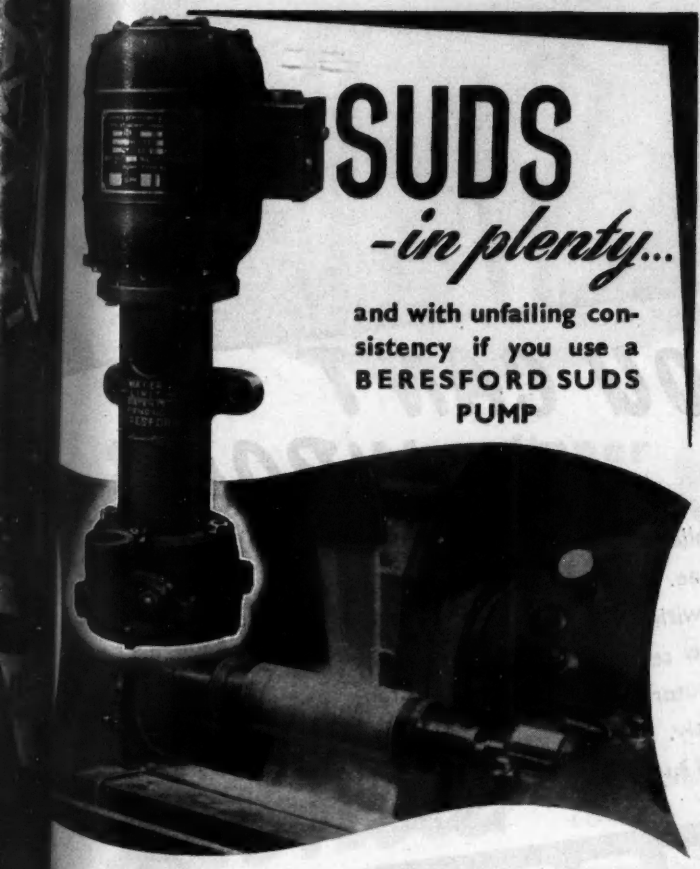

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Beresford Suds Pumps are made for outputs of 1·75 g.p.m. up to 45 g.p.m. and heads from 5 feet to 20 feet. Two types can be supplied, the first for immersion in the liquid, and the second for external tank mounting, with the inlet opening in the back of the lower flange.

Both types are equipped with filters and driven by totally enclosed motors, for alternating or direct current.

The pumps are well designed, of robust construction and capable of long use at minimum upkeep cost. Special plant can also be supplied for group feeding. If you would like more details, please ask for a copy of list GP.370.

The immersion type of pump is shown above. The external mounting type, illustrated below, has the inlet opening in the back of lower flange.

Beresford also make a range of single and multi-stage pumps, submersible electric pumps, contractors pumps, etc. The range is fully described in list GP.90—may we send you a copy?

BERESFORD Pumps ESTAB. 1860

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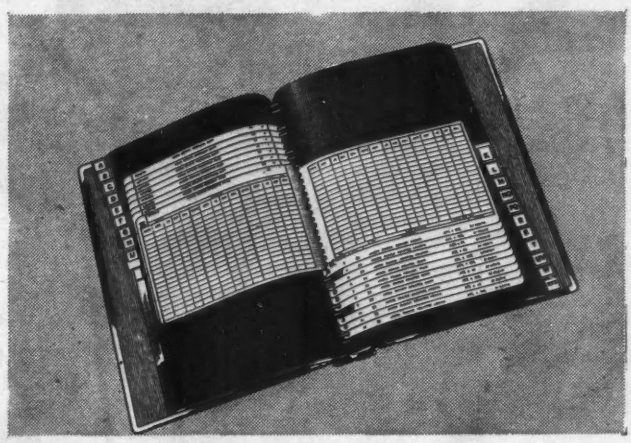

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Reasons: visibility, compactness, speed of entry, economy in cost and clerical labour.

As a result a number of records have been designed in conjunction with engineers for controlling a wide range of engineering activities. These are at the service of any executive who reads "The Engineer."

Below we give one or two typical examples of such records. If you are interested in any of them just jot the number of the record on your letter-heading and details will be sent you by return.

They are all applicable to the lightest and fastest visible recording system in existence.

SF 10162 Customer's Order Record
showing customer's name, address, drawing numbers, code numbers, dates, prices, due dates, despatch dates, quantities, invoice numbers, etc.

SF 10161 Pattern Record
with Pattern numbers, location, dates inward and outward, description, drawing number, machine, core boxes, pieces, etc.

SF 10110 Production Record
by product (or customer) showing operations, setting, machining, machine numbers, times, prices, materials with full description of tools, materials, etc.

SF 10164 Production Costs Records
with description of items, drawing and code numbers, materials needed, operations (automatics, capstans, drilling, tapping, milling, slotting, deburring, assembling) overhead costs, percentages, selling prices, etc.

SF 10163 Order Progress
with orders and sales, showing dates of intake and outgoings, prices, quantities, balances, order numbers, despatch dates, despatch note numbers, invoice numbers, values, etc., etc.

SF 10684 Purchase Records
showing suppliers, contracts, delivery periods, date of order, order number, quantities, prices and terms, actual deliveries, outstanding balances, materials required, whether need is normal or urgent, etc., etc.

Shannon Systems

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YOU CAN'T GO WRONG
A challenge . . . but one that we can substantiate all along the line. Even today, our organisation is broad enough to cope with almost any 'small tools' order that you may care to send in. Monks and Crane, Britain's Foremost Distributors, take pride in serving you . . . promptly and efficiently.
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Tel.: Middleton 3654 (3 lines)
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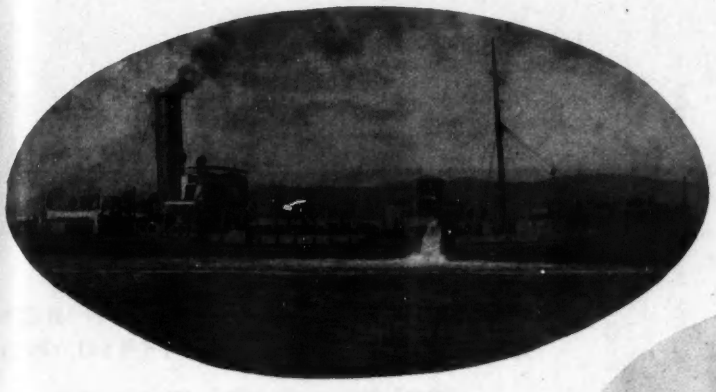
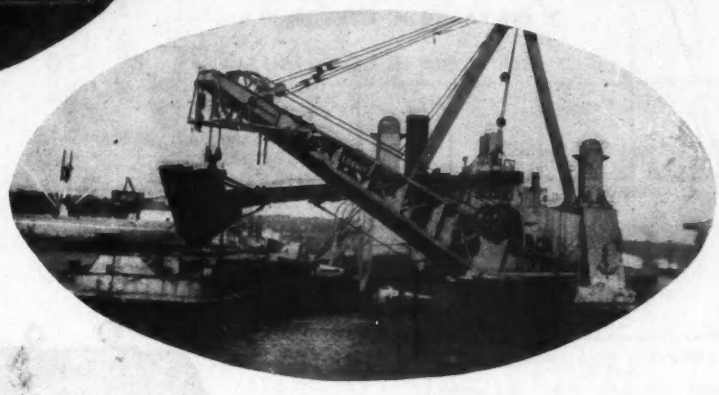


a suction dredge for South Africa



a dipper for France

Throughout the world Lobnitz Dredges play their part in keeping sea lanes open and safe. Whatever the type of Dredge required, Lobnitz have the efficient, the economical answer.

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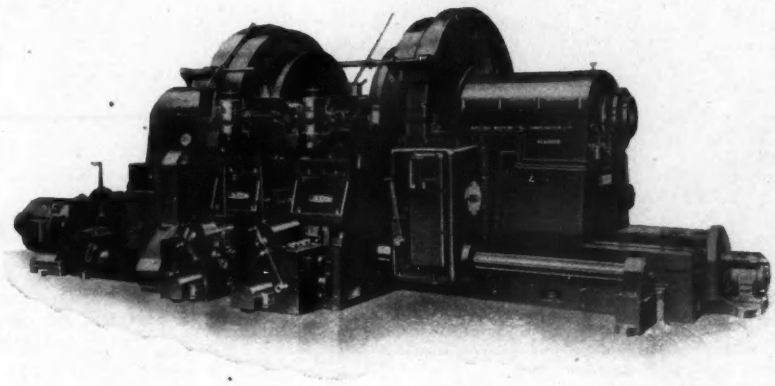

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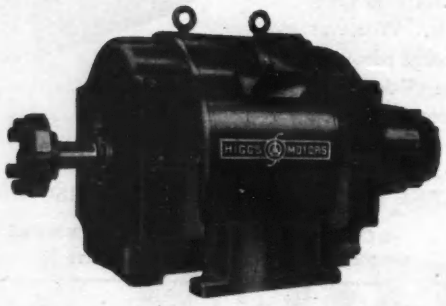

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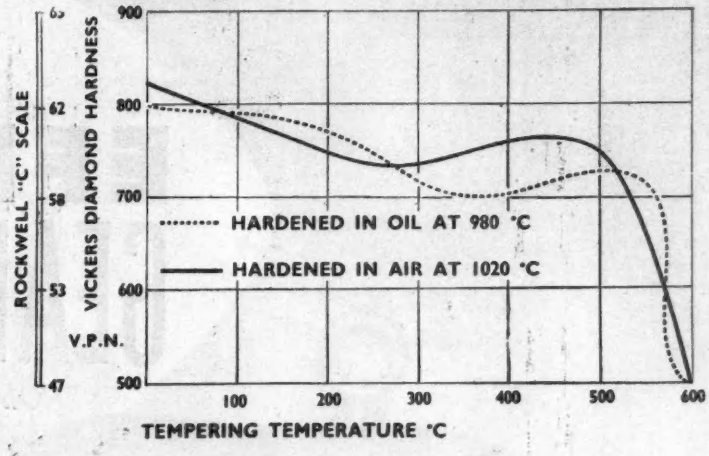

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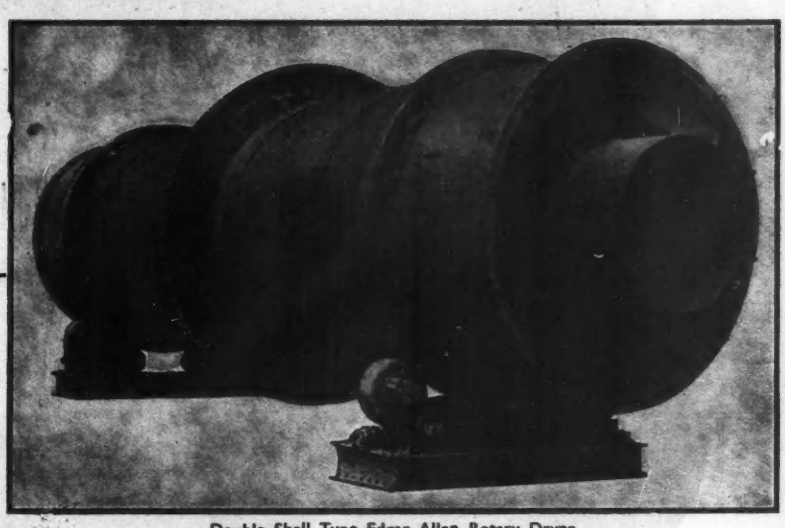

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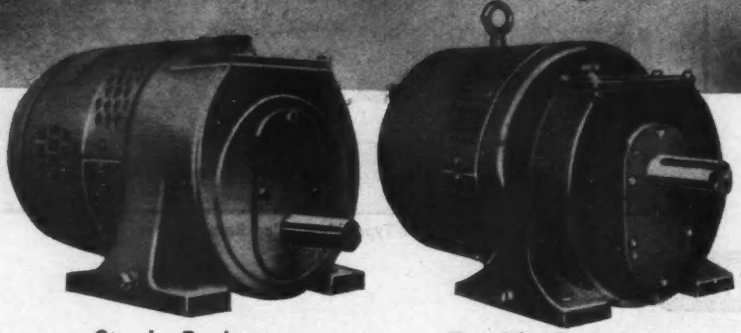

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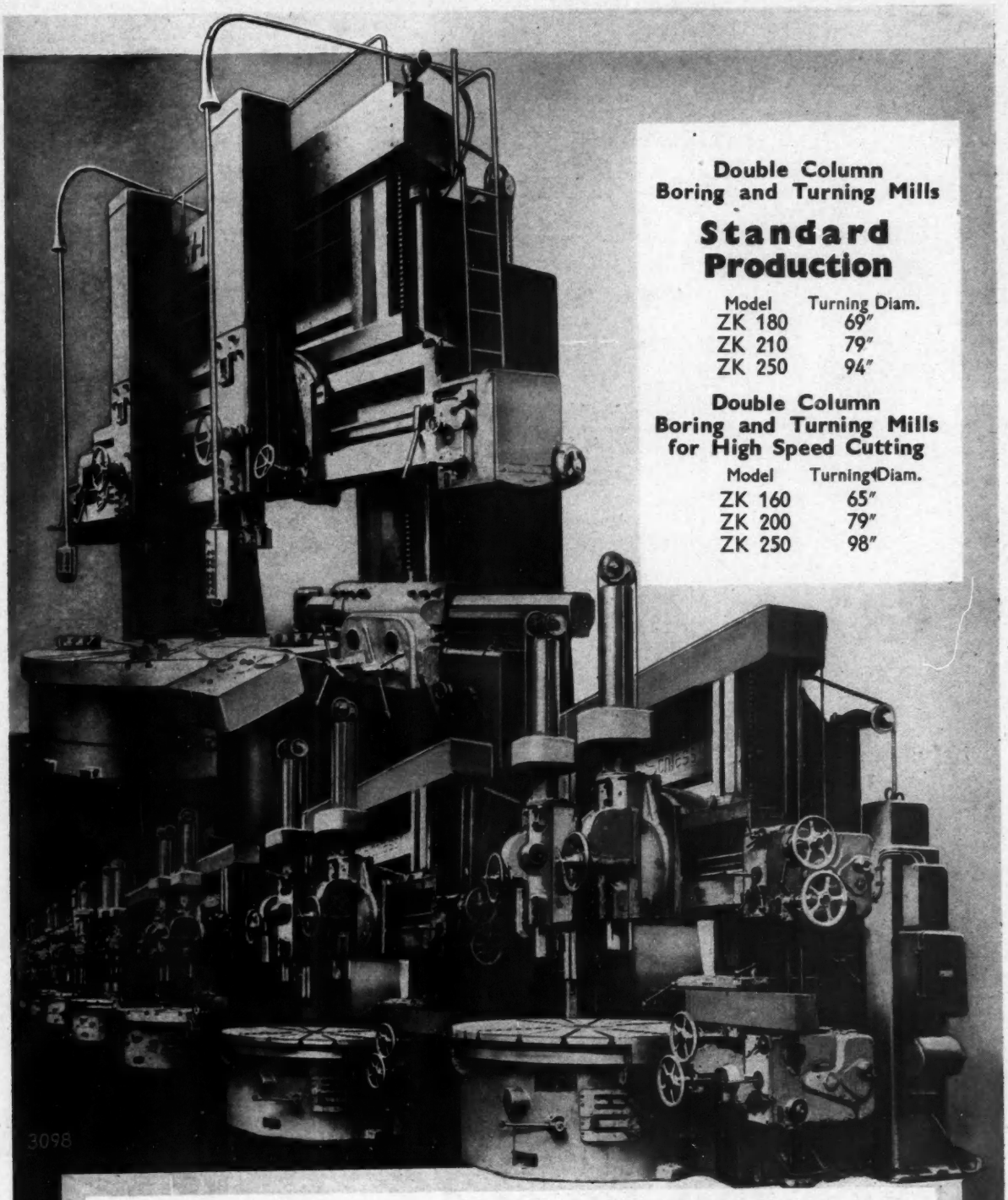

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ZK 180	69″
ZK 210	79″
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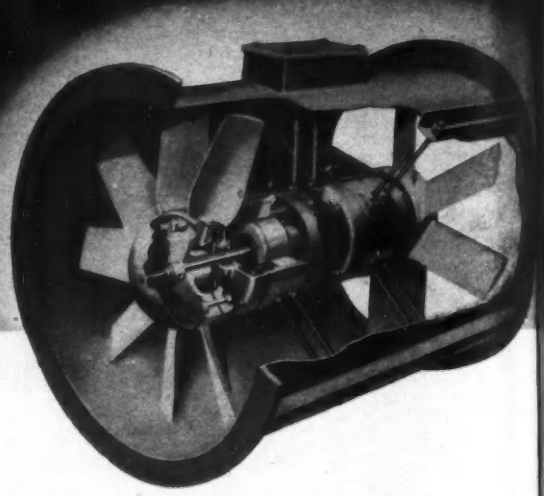

What sound level?

The sound level of *Aerofoil* fans is quoted in decibels. The audibility of the fans can be assessed reliably by comparing the sound level ratings with the background noise of the situation in question. With Woods fans guess-work based on tip-speed is avoided. Details of typical background noise together with other sound level data of assistance in fan selection are given in *Aerofoil* publication V.1089 and Data Sheet VW.101.

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AN ASSOCIATE COMPANY OF THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

'ENGLISH ELECTRIC'

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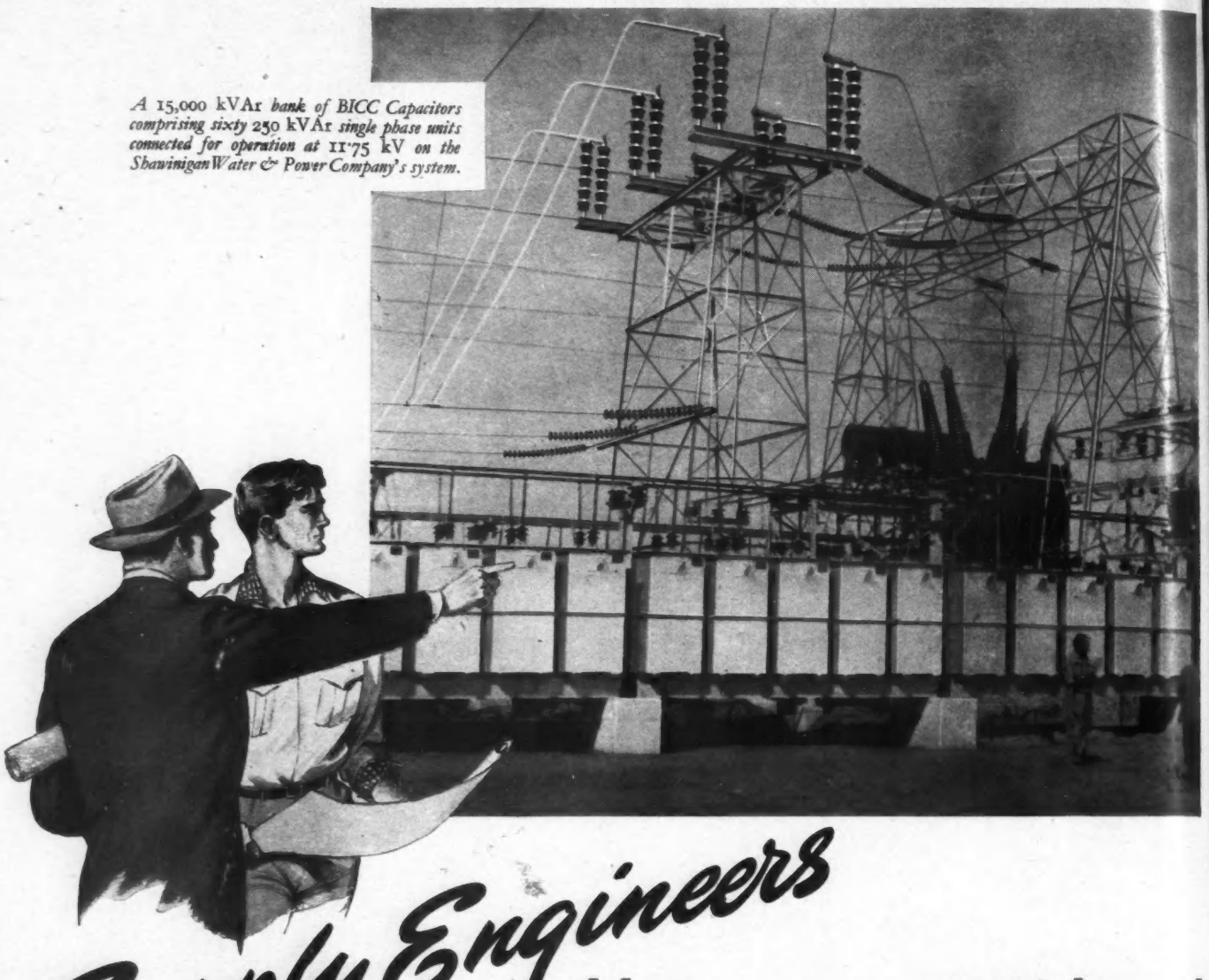

A 15,000 kVAr *bank of BICC Capacitors comprising sixty* 250 kVAr *single phase units connected for operation at* 11·75 kV *on the Shawinigan Water & Power Company's system.*

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Further information is available in Publication No. 278T.

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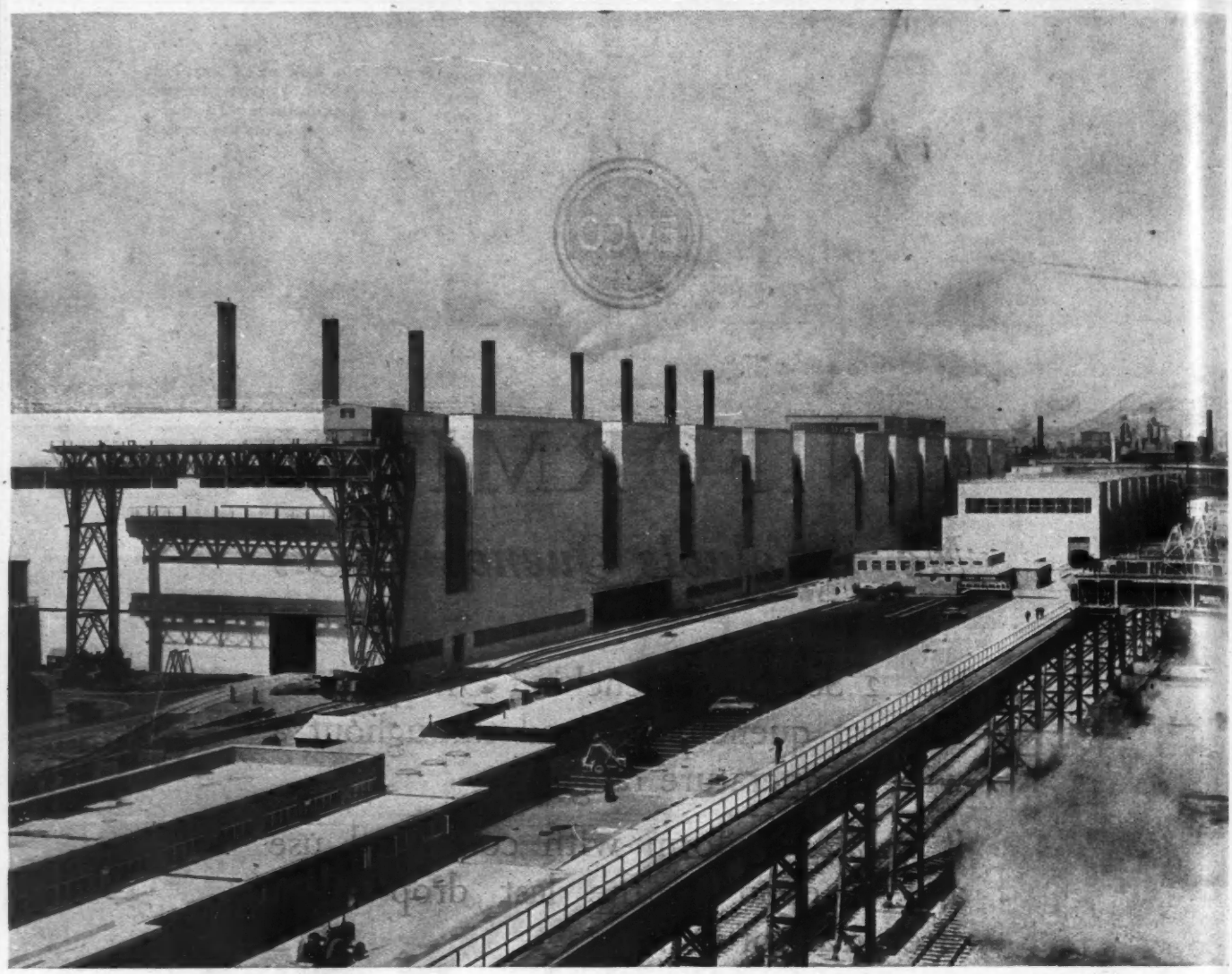

General View of Abbey Works

THE ABBEY WORKS, built adjacent to the existing Works, consists of a Melting Shop, 80″ Continuous Hot Strip Mill, Three-Stand Cold Reduction Mill and ancillary plant.

PRODUCTS OF THE COMPANY ARE :—

Hot Rolled and Cold Reduced Sheets and Coils up to 72″ sheared width in qualities for auto-bodies, vitreous enamelling, extra deep drawing, etc. · Galvanized Flat and Corrugated Sheets · Electrical Sheets for Dynamos and Transformers · Blackplate · Hot and Cold Reduced Tinplate both hot dipped and electrolytically tinned · Plates ⅛″ thick and upwards by up to 72″ wide · Flange, Bullhead and Bridge Rails · Fishplates · Steel Railway Sleepers · Sections · Slabs · Basic Pig Iron · Coke and By-Products · Sized Limestone.

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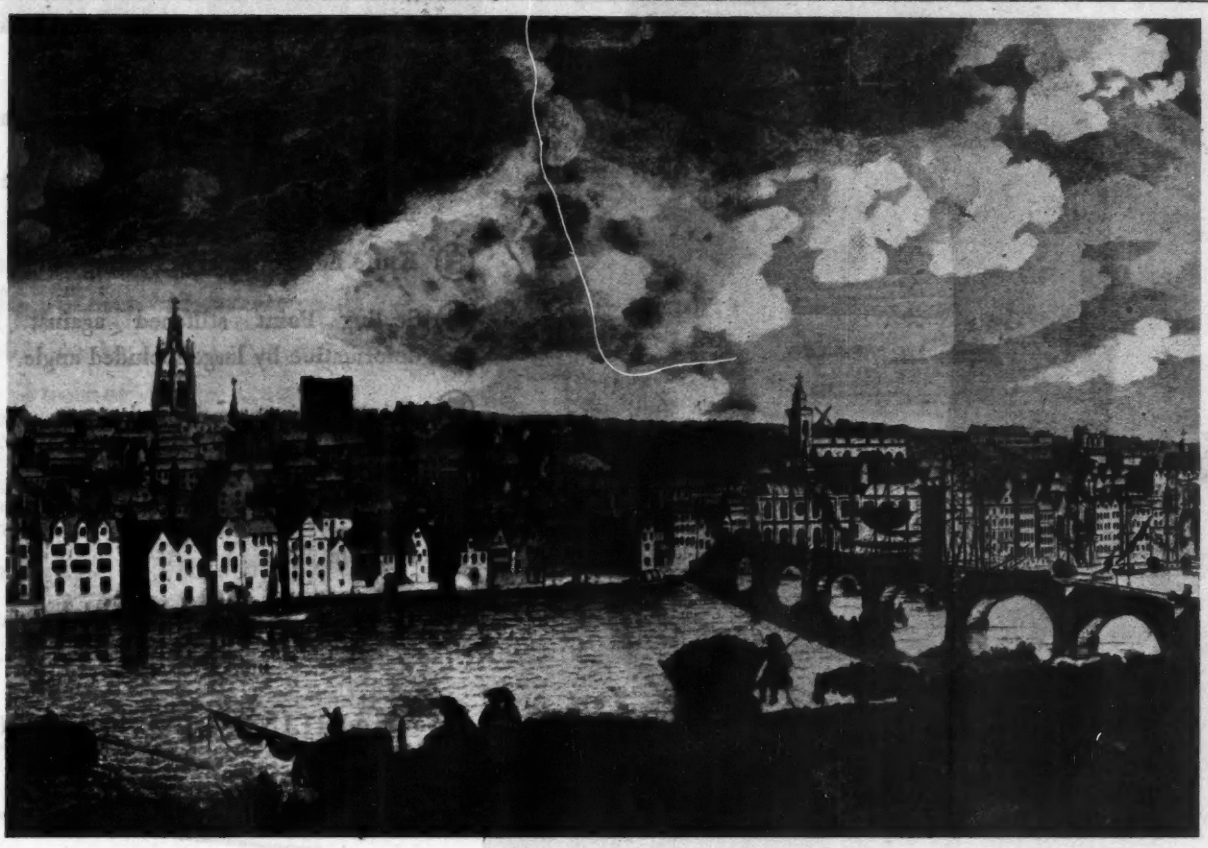
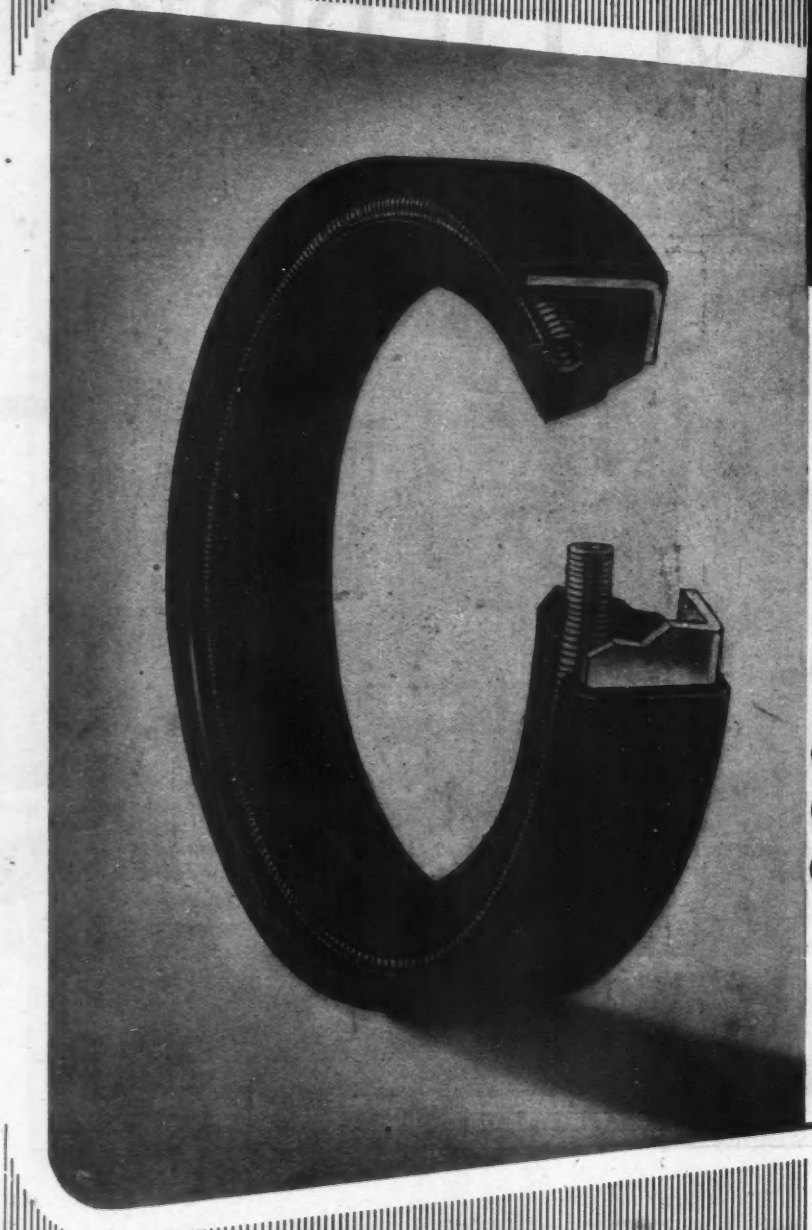
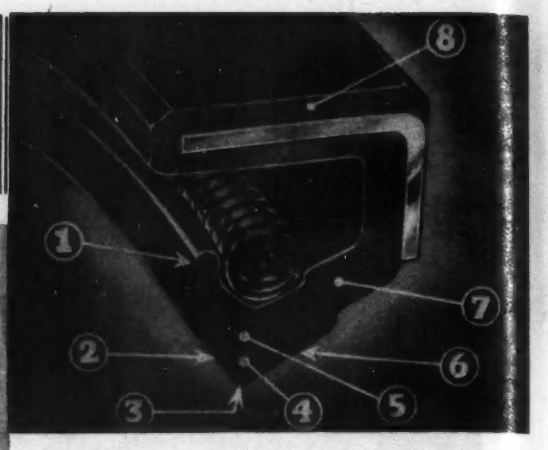


. . . in their fiftieth year on Tyneside

wish all their friends a happy Christmas

and a Prosperous New Year.





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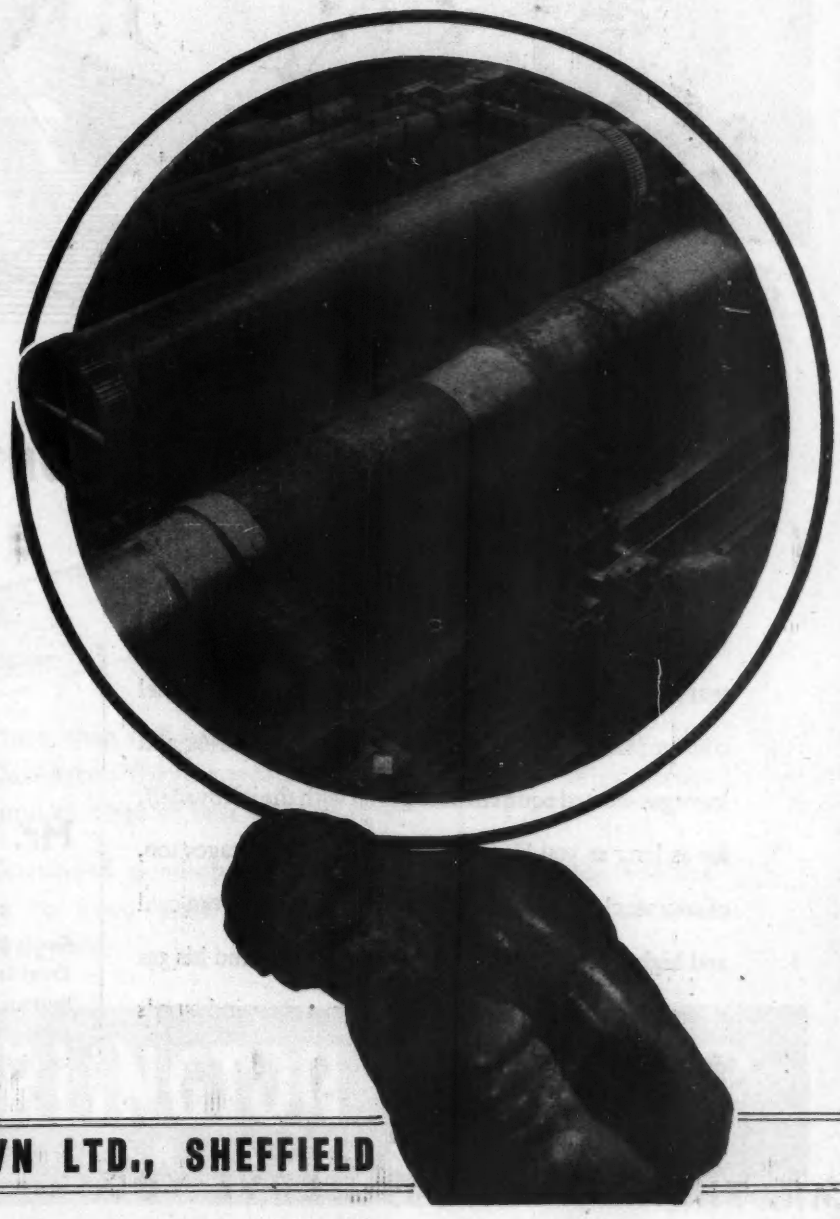

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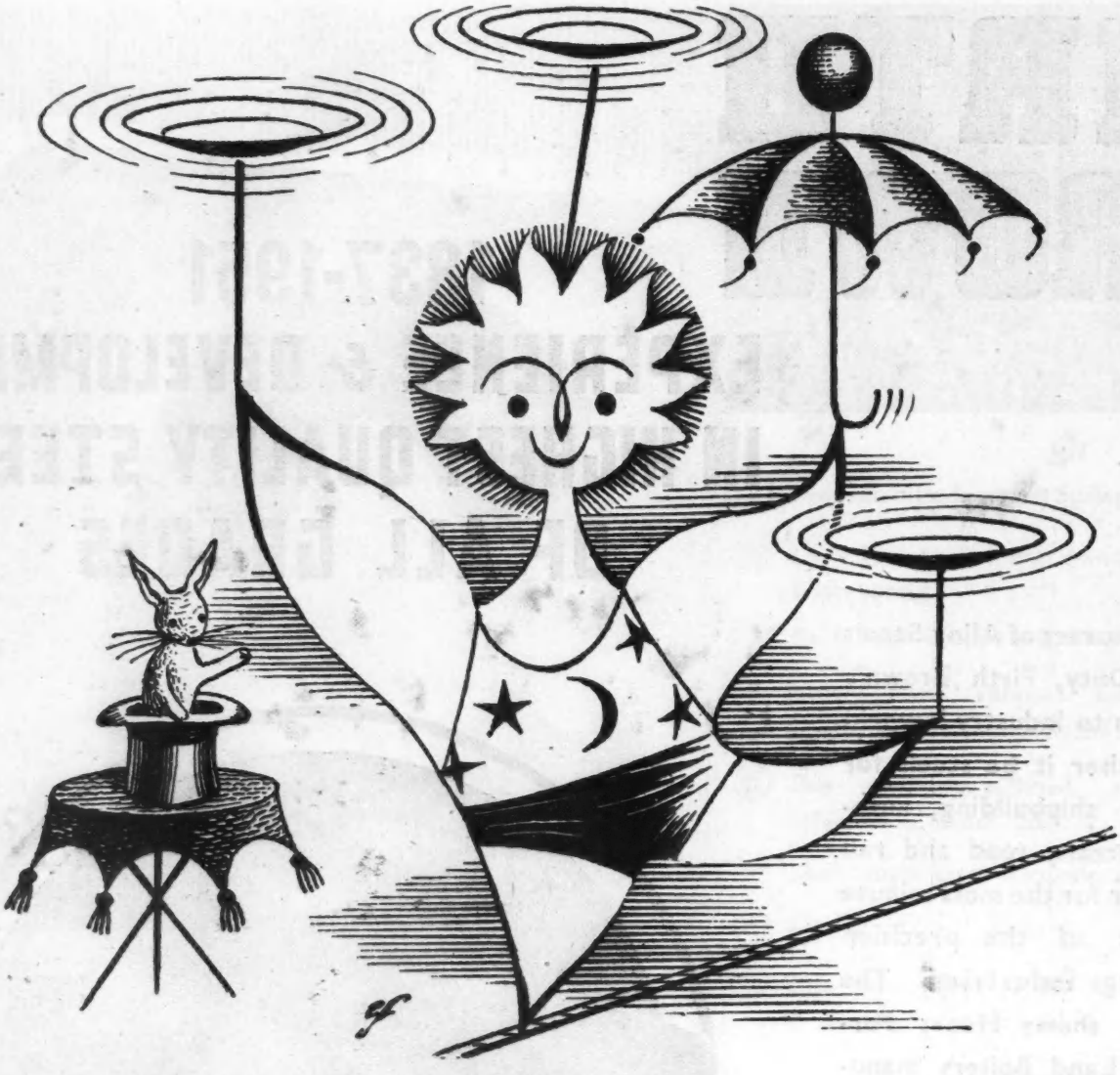

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Mr. Therm on a bicycle made for millions

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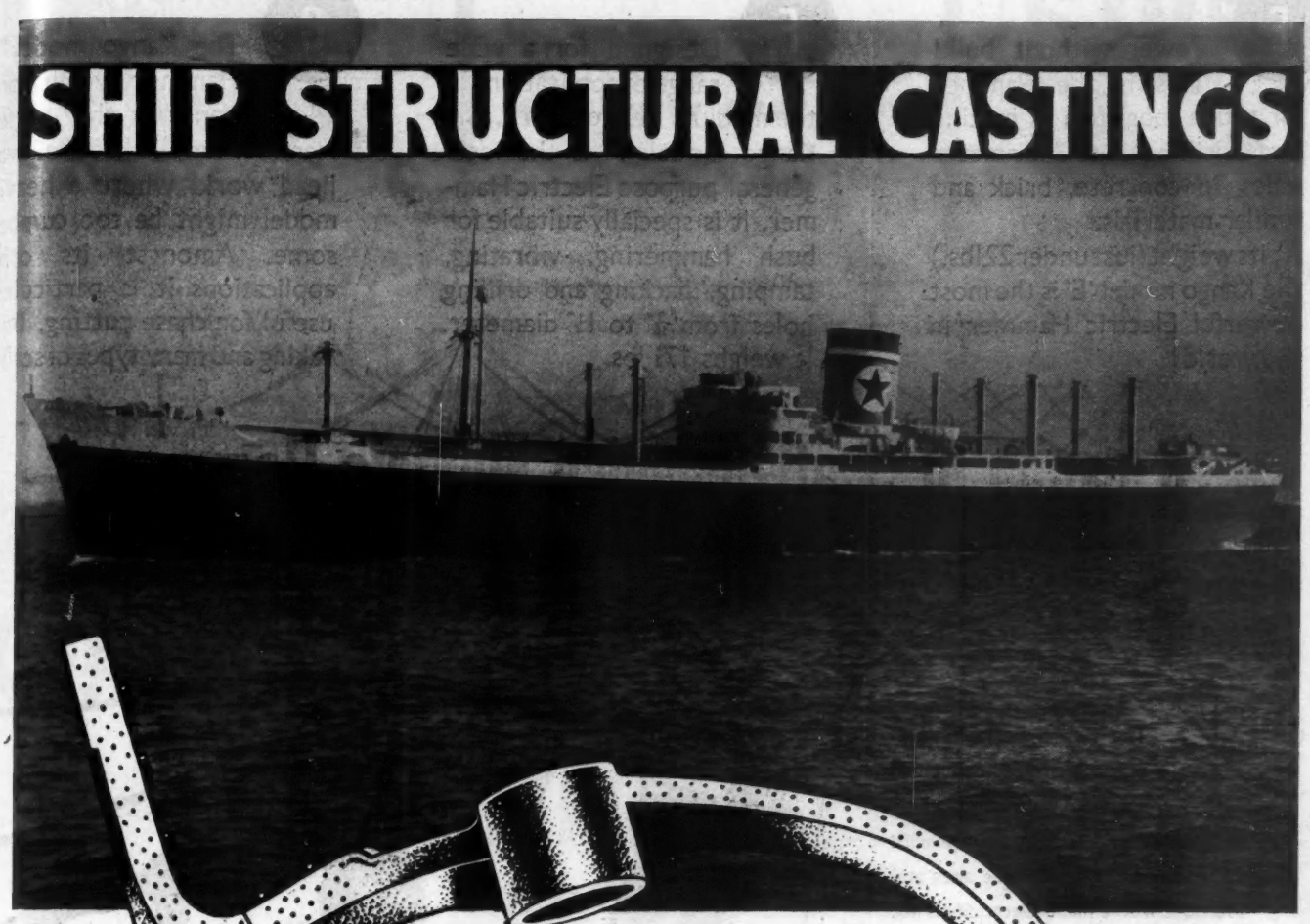
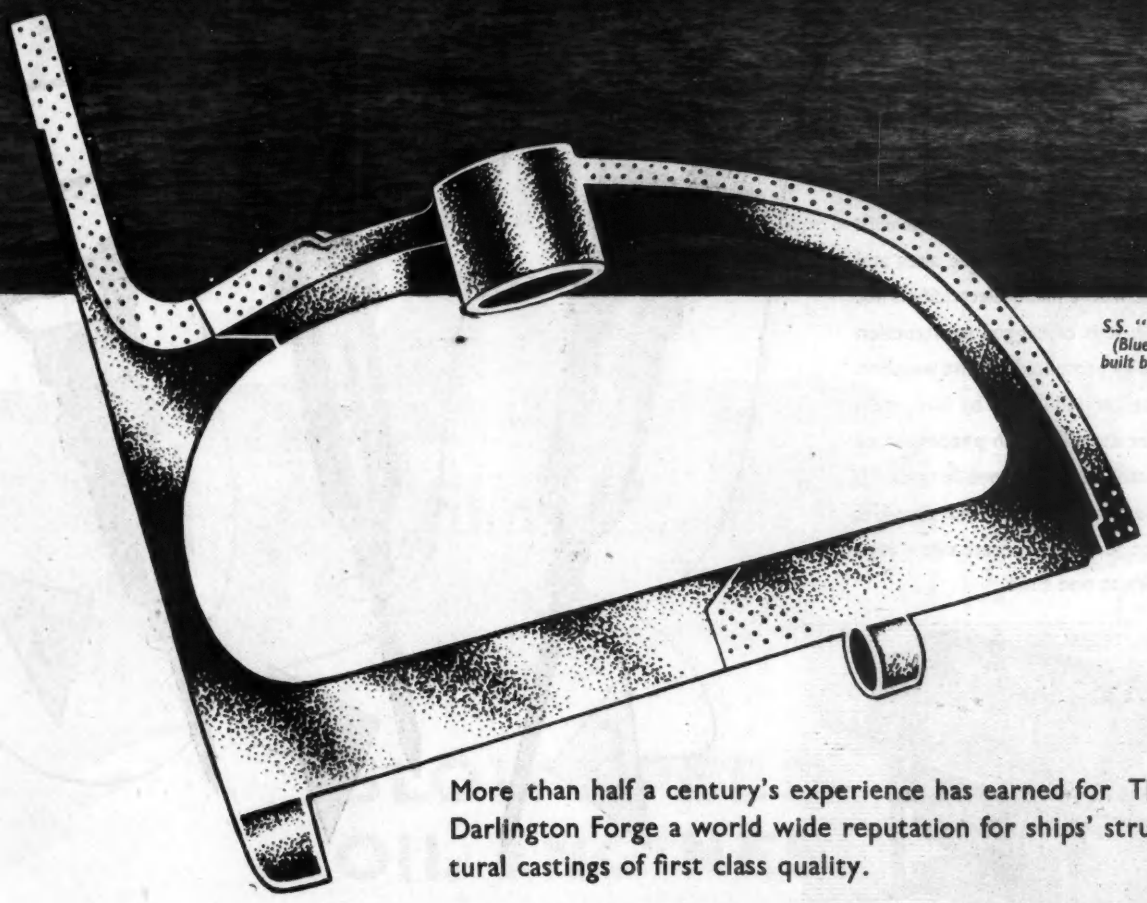


S.S. "Tasmania Star" (Blue Star Line Ltd.) built by Cammell Laird & Co. Ltd.



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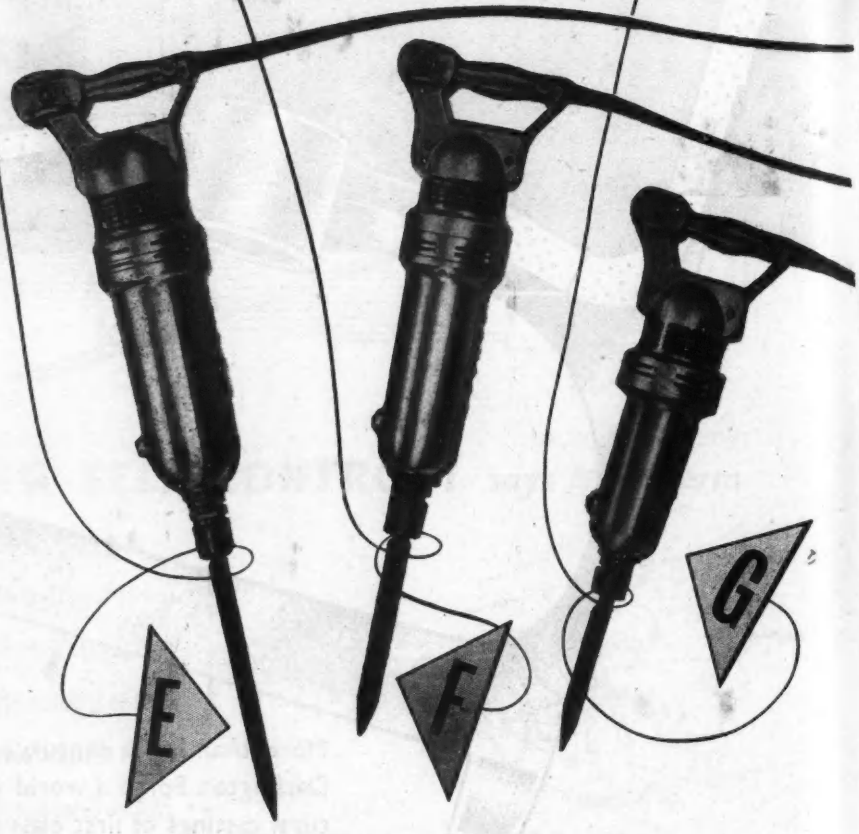
At its weight (just under 22 lbs.) the Kango model 'E' is the most powerful Electric Hammer in the world!

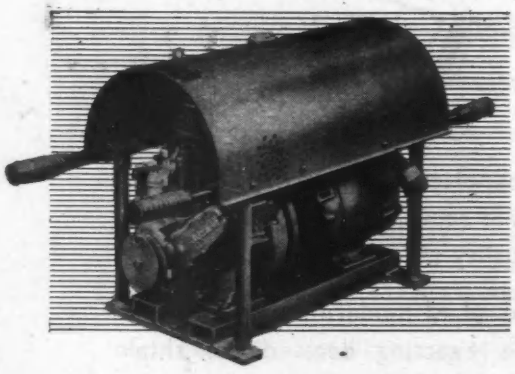
F Designed for a wide range of applications in the medium field of work, the Kango model 'F' is the ideal general purpose Electric Hammer. It is specially suitable for bush hammering, vibrating, tamping, hacking and drilling holes from $\frac{3}{16}$" to 1½" diameter. It weighs 17½ lbs.

G The Kango model 'G' Hammer weighs only 14 lbs. and is the perfect Hammer for all classes of overhead work where a heavier model might be too cumbersome. Amongst its other applications it is particularly useful for chase cutting, brick raking and many types of scaling.

A range of 3 all-purpose Electric Hammers — for service everywhere *



* The Kango Portable Generating set is designed specially by Auto Diesels Ltd., Uxbridge, Middlesex, for use with Kango Hammers on outside sites and locations where mains electricity is not available. It is of rugged construction and is fully protected against weather. It can be carried easily by two men, or can be supplied with pneumatic, or solid tyred wheels, or mobile tracks. It is economical in price and provides sufficient power to operate two Kango Hammers at one time.



The Kango Portable Generating Set — *Supplied only by* ***Kango Electric Hammers Ltd.,*** *or their distributors*

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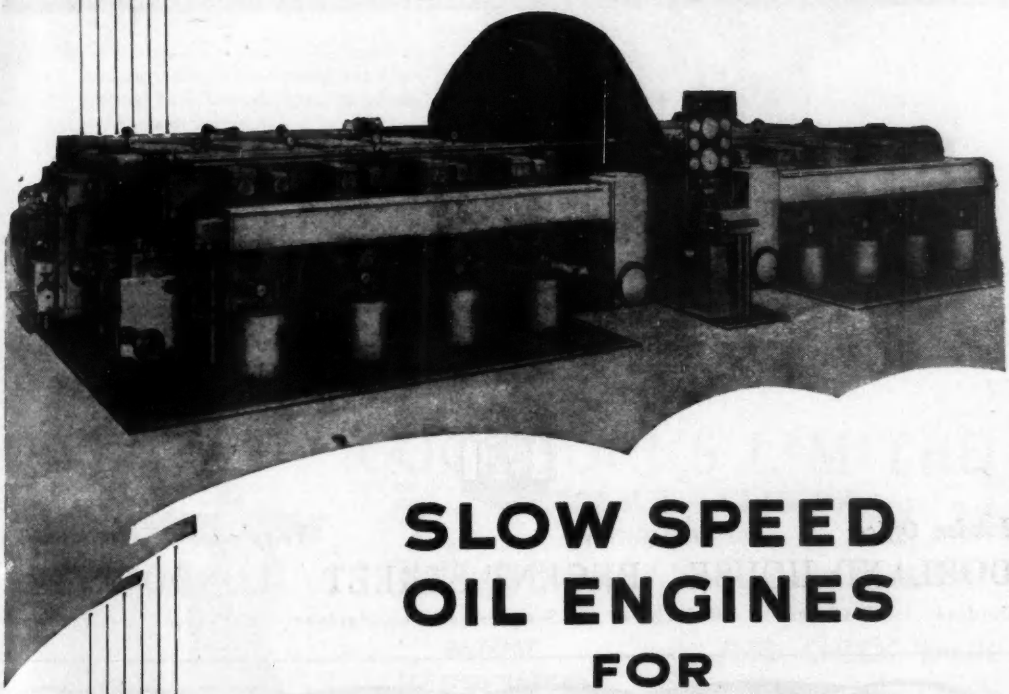

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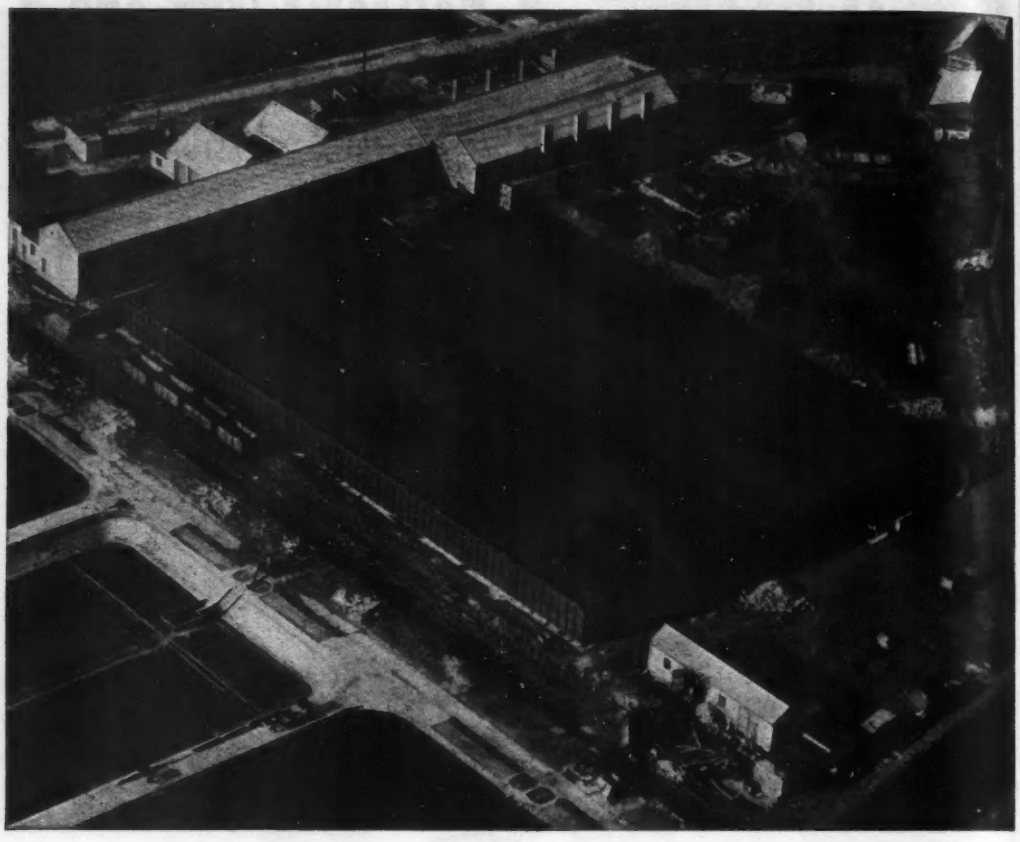

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DORLAND HOUSE REGENT STREET LONDON S.W.1
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OF HIGH REPUTE
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PROPELLER FAN

to do the job

Whatever the situation G.E.C. Propeller Fans have a world-wide reputation for efficient performance and dependable service.

- **Air Displacement Figures** comply with B.S.848/1939.
- **Motors** have been designed specifically for fan duties.
- **Reliability.** The fan motors are very liberally rated and the fans are robustly built for long life.
- **Quietness.** The motors, the impellers and the method of mounting (see illustration) have been designed to obtain quietness of operation.
- **Condensers** of single-phase fans are neatly housed within the motor body.
- **Pressed Steel Mounting Rings** are employed to provide sufficient flexibility to prevent the possibility of fracture when bolted to rough surfaces.
- **Resilient Suspension** (British Patent No. 494973) contributes to quiet operation by isolating the fan from the fixing surface and thereby minimising the transmission of any noise or vibration.

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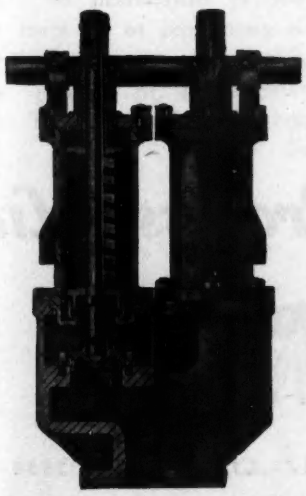

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SAFETY VALVE

Approved at 50% reduction in Area of Ordinary Safety Valve.

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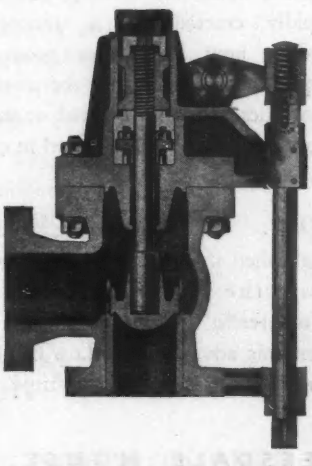
NON-RETURN TYPE

NON-HAMMERING ANTI-FOULING

Lever gear for operation eliminates low mechanical efficiency of spur gear type.

Codes: ABC (6th Edition) Liebers, Marconi, International



Full particulars on application

HEAD WRIGHTSON PROCESSES SPECIAL PRODUCTS DIVISION offers design, erection and maintenance services on Fluor Counterflo Cooling Towers, and other special products of the Fluor Corporation Limited.

THE *counterflo* COOLING TOWER

3-Cell Counterflo Cooling Tower, view of fan decks; note 2-speed fan motors mounted in easily accessible position outside fan stacks.

DESIGN DATA. When requesting quotations and recommendations on Counterflo Cooling Towers, the following information should be given: 1. Gallons per minute of water to be circulated in tower. 2. Inlet temperature to tower. 3. Outlet temperature from tower. 4. Wet bulb temperature occurring during periods of peak load. 5. Description of site as to whether it is clear or partially obstructed, size of area available for new tower as well as for possible expansion etc.

Efficient water cooling combined with flexibility

PREFABRICATION. Extensions to existing Counterflo Cooling Towers can be rapidly erected. It is unnecessary to budget now for future cooling water requirements. Demands for precise water quantities and required final water temperatures can be accommodated in one of the 66 Counterflo models.

COST. Recent economic studies have established that in addition to low capital cost, the annual cost of owning 'Counterflo' Towers shows distinct economic advantages. Low capital cost is partly due to short erection time.

ECONOMIC SITING. Counterflo units can be sited at the point where cooling water is required. Thus considerable savings can be made in pipework costs. Counterflo towers may be adapted to all requirements where ground space is limited. Multi-cells allow partial shut down when required.

LESS MAKE-UP WATER. Loss of water due to entrainment or "carry-over" is guaranteed to be lower than 0.2% of water in circulation, showing considerable saving in make-up water costs and the elimination of spray nuisance.

Head Wrightson Processes Ltd.

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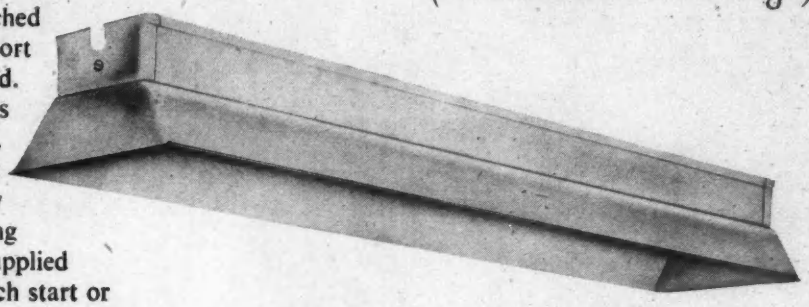
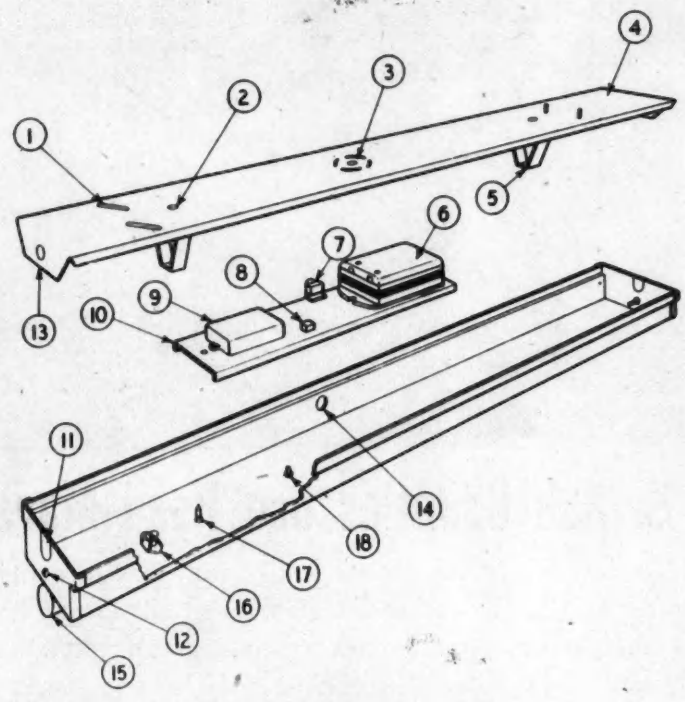
A new range of fittings for fluorescent lamps

This entirely new range of Metrovick fluorescent fittings is based on a standard channel with interchangeable reflectors.
Different styles of reflectors are readily attached to the channel and for stocking and transport they can be nested together and easily stacked. No live parts are exposed when the reflectors or enclosures are removed for cleaning. All the fittings are constructed of sheet steel, bonderised and stove enamelled. They are complete with lampholders and wiring and unless it is stated otherwise they are supplied complete with auxiliary gear either for switch start or instant start as required.

A complete unit
(Closed-end metal trough)





Exploded view of Basic Channel for Metrovick Fluorescent Fittings

Easily stocked
Easily erected
Easily maintained

Send for leaflet 4121/21-2

1. Fixing slots for close ceiling mounting.
2. ¾ in. conduit knockout for conduit or chain suspension.
3. B.S. conduit box entry.
4. Backplate.
5. Bracket for securing channel to backplate.
6. MRJ Choke.
7. Starter switch and socket.
8. Terminal block and earthing terminal.
9. Capacitor.
10. Gear tray.
11. ¾ in. conduit knockout for end entry.
12. Screws for attaching endplates.
13. ¾ in. conduit hole to terminate end entry.
14. Starter hole.
15. Flicker shield.
16. Oddie Clip holding reflector.
17. Captive screw for channel fixing.
18. Stud for fixing gear tray.

METROVICK

METROPOLITAN-VICKERS ELECTRICAL COMPANY LTD., ST. PAUL'S CORNER, 1-3 ST. PAUL'S CHURCHYARD, LONDON, E.C.4.

Member of the A.E.I. group of companies

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★ *Here is one of the Road-Marshalls that wears the green livery of the Lancashire County Council. It is shown at work on surface dressing operations on a county road between Preston and Eccleston.*

Photograph by courtesy of James Drake, Esq., B.Sc., A.M.I.C.E., M.I. Mun. E., County Surveyor and Bridgemaster.

Why 37 British Counties use Road-Marshalls

BECAUSE Road-Marshalls are economical to run, easy to maintain, and have exceptionally long lives: because trouble-free electric starting is standard equipment: because tough, instantly reversible transmission prevents 'dwell': because a complete range of extras (including fluidrive and power steering) can be fitted. These are some of the reasons why 37 British Counties have selected Road-Marshalls.

The Road-Marshall Range, the most modern in production in Britain, offers you a choice of three-wheel variable weight rollers in sizes from 7 to 14 tons, plus a new 5½ to 8 ton Tandem Roller designed especially for finer top surfacing. If you would like literature, you have only to drop us a line. Marshall Sons & Co. Ltd., Britannia Works, Gainsborough, Lincs. Telephone: Gainsborough 2301.

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BIGWOOD

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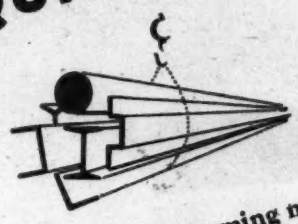
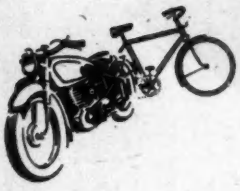
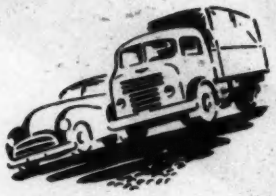


Bar and section straighteners, reeling machines, hot saws, drawbench plant, centreless bar turners, plate and billet shears, roller levellers.

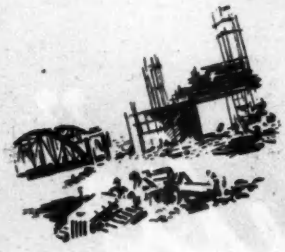
Roll forming machines for tube and sections, tube butting machines, friction screw presses, cycle sprocket rolling machines.





Panel forming stretchers, wheel rim making plant, "Bulldozer" forging machines, gang slitters for sheet and strip, oxy-acetylene tube welders.

"Open-end" section bending machines, plate bending rolls, guillotine shears, bending and straightening presses, plate edge curving presses.



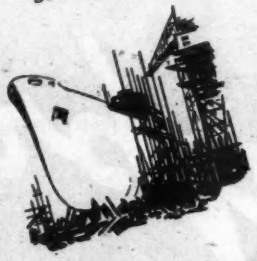
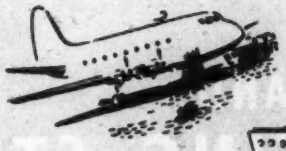
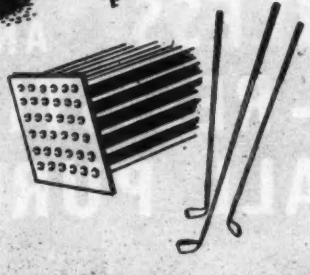


Plate levelling machines, shears, plate joggling machines, screw presses, 4 and 5 roll plate bending and straightening machines.

Sheet and section stretchers, precision levellers, slitting and coiling plant, de-twisting machines, panel forming stretchers.





Tube straightening machines, tube making plant, tube testing machines, expanding and reducing machines, drawbenches, rulers.

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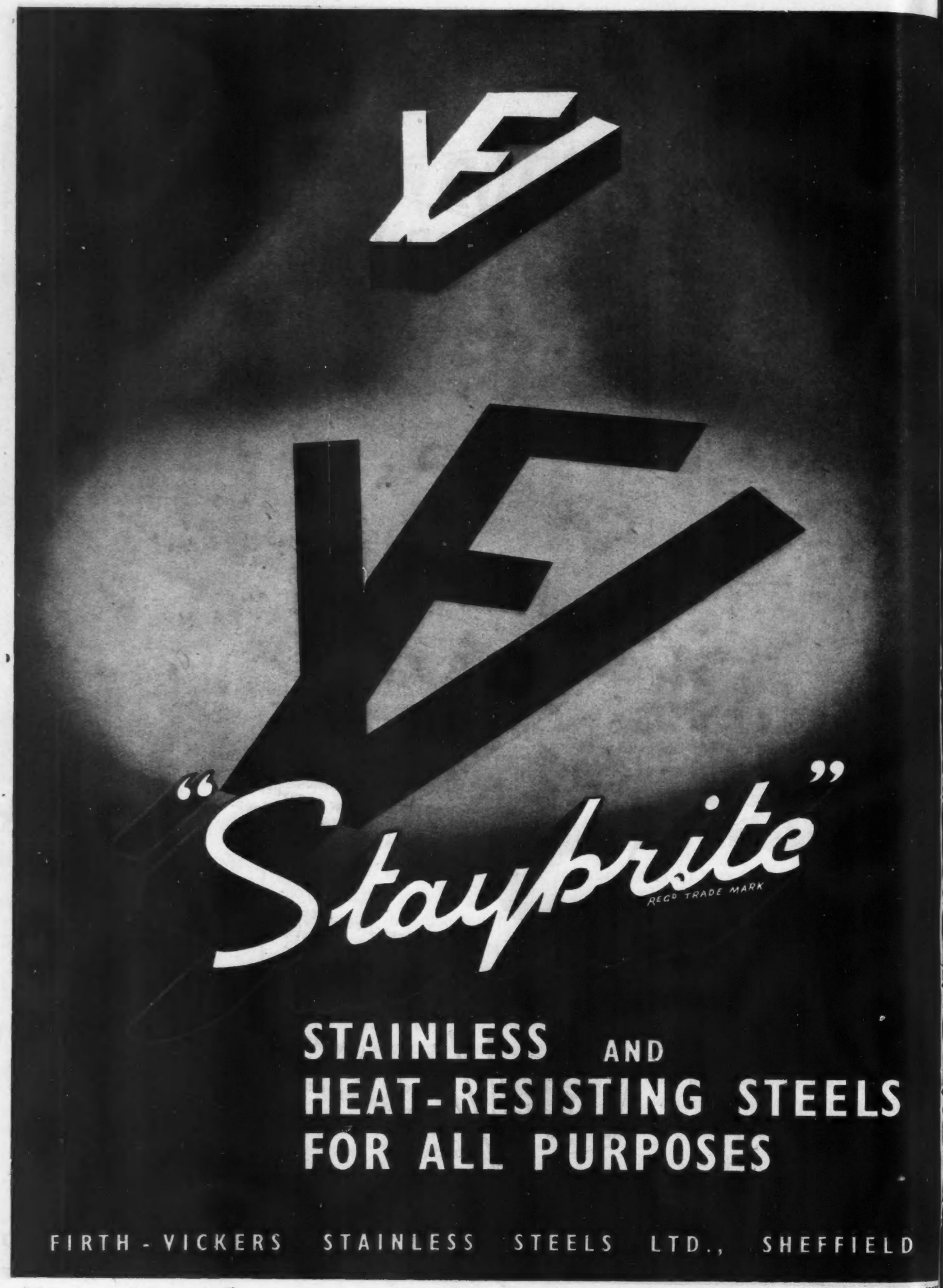

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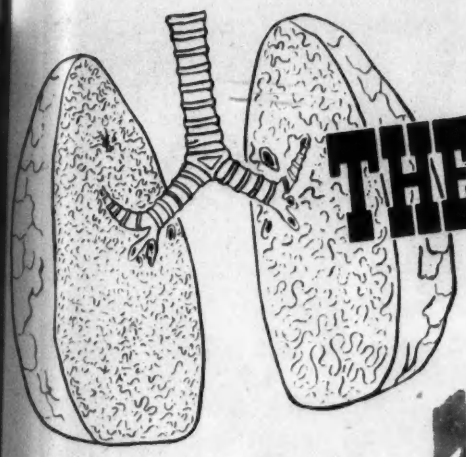

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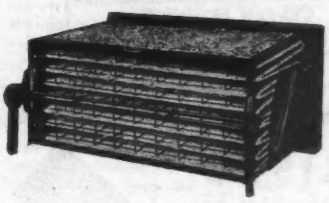
Just as the filtration of the air which the workers breathe safeguards their health, so does the filtration of the air consumed by machines provide a valuable insurance against breakdown and needless depreciation. In thirty years of constant development nothing has been found to improve upon the basic principles of VOKES filtration, and today the degree of protection afforded to man and machine by VOKES filtration remains unsurpassed. Remember too—rigid adherence to the stated servicing periods and the replacement of elements when necessary ensures that the unrivalled efficiency of VOKES filters is maintained. Full details of the VOKES range for all air conditioning applications will gladly be supplied on request.



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Pioneers of scientific filtration

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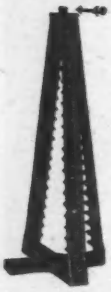

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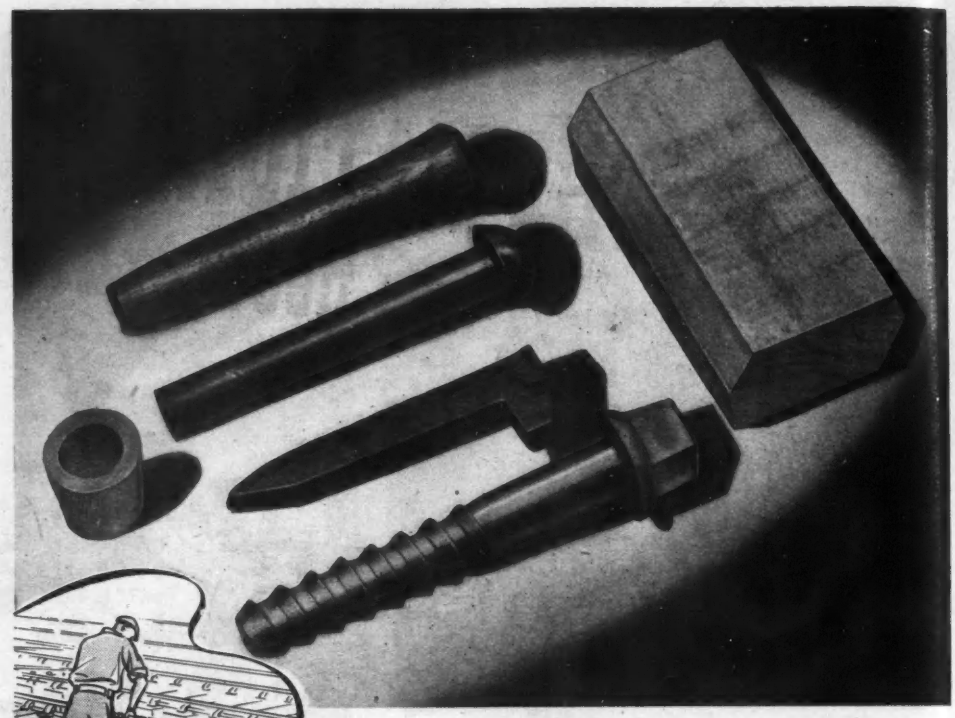

TRACK MAINTENANCE

KEYS and chairscrews, fishplates and so on must eventually come to the end of their useful life—but it is false economy to wait until a costly breakdown draws attention to the inevitability of this fact.

The wisest course is to make inspection and replacement a routine task, and always hold a full range of WARD tools and spares to tackle the work of replacement regularly as each item needs attention.

One thing is certain : regular maintenance and track overhaul is an expense which pays for itself in trouble-free operation and freedom from breakdown.

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CHAIRS, CHAIRSPIKES, CHECK CHAIRS, CONCRETE and TIMBER SLEEPERS, CROSSING TIMBERS, DISTANCE BLOCKS, DOGSPIKES, FELT PADS, FERRULES, FISHBOLTS, FISH PLATES, KEYS, LEVER BOXES and RODS, RAGBOLTS, F.B. and B.H. RAILS, SLEEPER BOLTS, SOLE PLATES, TIE RODS, TRENAILS and COMPLETE TURNOUTS or replacement parts.

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for everlasting accuracy

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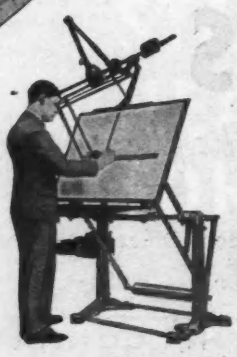

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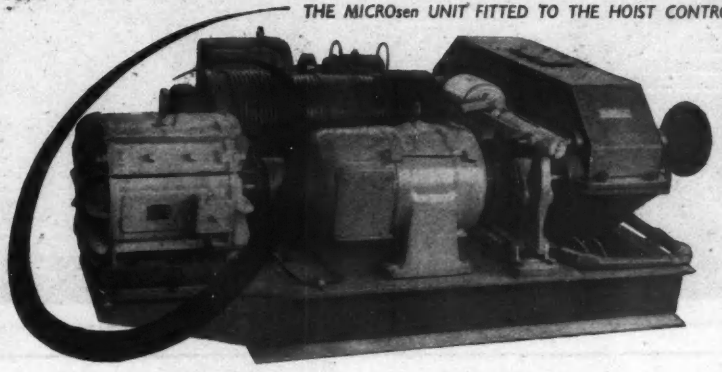
*MICROsen

is the registered name of

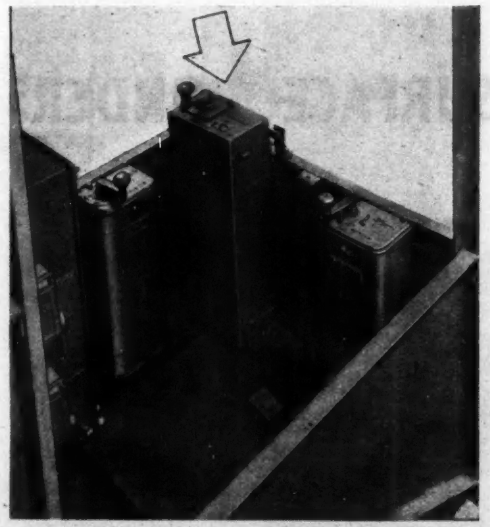
A NEW CREEPING SPEED CONTROL FOR A.C. CRANES

THE MICROsen UNIT FITTED TO THE HOIST CONTROL



MICROsen, a small, compact unit, gives progressive speed variation from 100% to 10% of full speed in stages on hoist and lower, cross or long travel motions. It is essentially simple, requires no maintenance, and is low in both initial and operating costs.

HOIST CONTROLLER INCORPORATING MICROsen



MICROsen UNITS CAN BE FITTED TO THE MAJORITY OF EXISTING A.C. CRANES

MICROsen EFFICIENCY

The MICROsen Unit enables the equivalent of D.C. Speed Torque characteristics to be obtained from A.C. cranes. The effectiveness of the unit is unimpaired by variations in load and speed through a very wide range of operation and permits a delicacy and accuracy of control not previously achieved by Creeping Speed Systems.

SIMPLICITY OF INSTALLATION AND MAINTENANCE

The MICROsen Unit consists basically of a stationary D.C. field system and a high torque squirrel cage rotor which is usually coupled direct to the tail shaft of the hoist motor. It is entirely self-contained and can be fitted with only a minor alteration to the existing wiring. Since the field system is stationary and the rotor has no electrical connections, there are no moving electrical parts requiring maintenance. MICROsen, therefore, will operate satisfactorily in normal conditions of crane maintenance and needs no additional care.

MICROsen ADAPTABILITY

Every MICROsen Unit is individually tailored to its purpose and to the specific site conditions in which it will work. A variety of characteristics for varying purposes can be obtained. MICROsen is available for Cross Traverse and Long Travel directions, if required.

SIMPLICITY OF OPERATION

The operator of an overhead crane fitted with MICROsen Control has no additional controls, levers or brakes to contend with. Both Creeping and Full Speeds on any load are obtained through a single standard type drum or master-controller.

MICROsen ECONOMY

Unlike many of the Creeping Speed systems now on the market, MICROsen is low in initial cost and, depending on the type of installation required, necessitates only a comparatively small extra charge. In use the additional current consumed is negligible even when minimum Creeping Speeds are in operation, e.g., 10 ton Crane—1·5 Amps.

BRAKE AND SAFETY RELAY

A simple D.C. electro-magnetic brake is used with the equipment and is supplied from the rectifier which feeds the MICROsen field system. A safety relay is incorporated with this brake, thus avoiding any possibility of "run-away" in the event of electrical or unit failure.

★ *(Patents pending)*

MICROsen . . . MICROSENSITIVE A.C. CRANE CONTROL BY . . .

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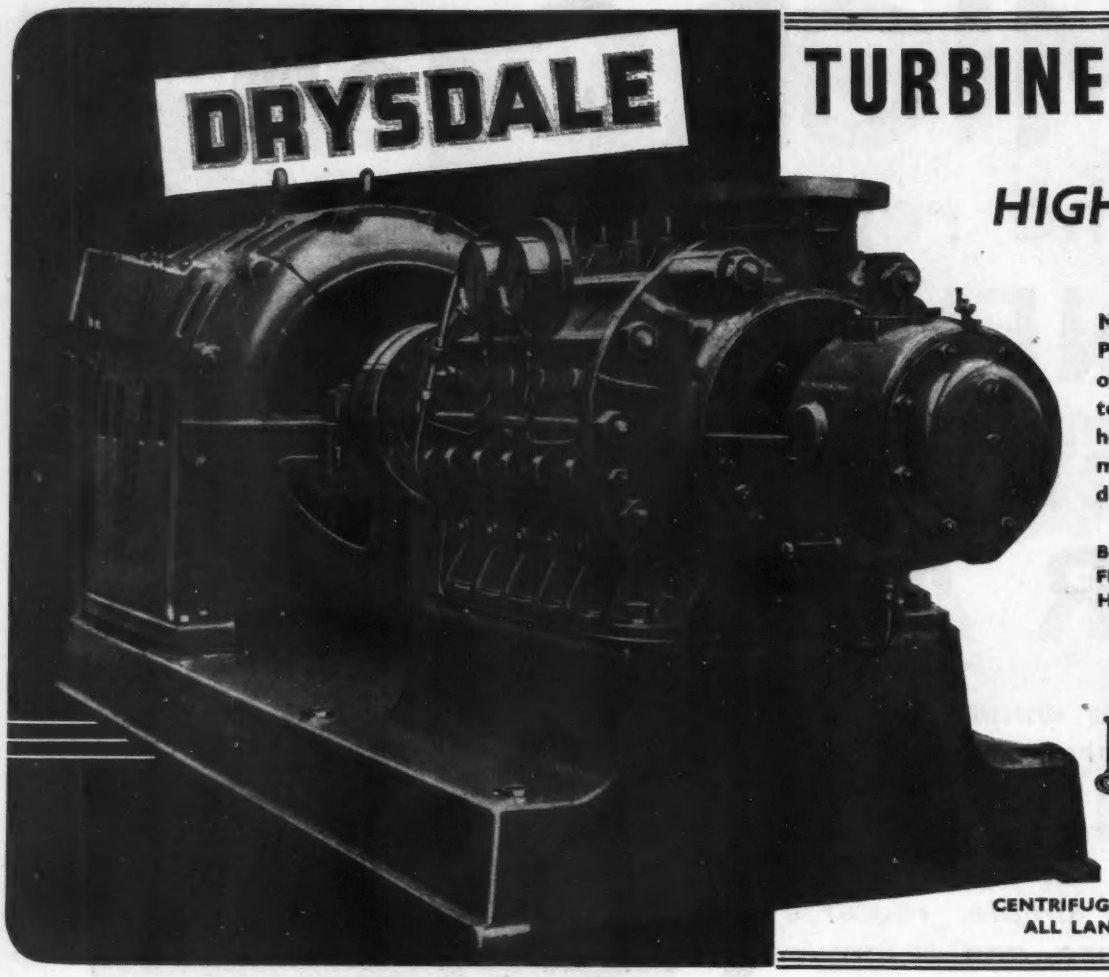

TURBINE PUMPS for HIGH PRESSURE PUMPING

Multi-stage Ring Turbine Pumps are available in a range of sizes with capacities up to 3000 gallons per min. and heads up to 1200 feet for all medium and high pressure duties.

MINE DRAINAGE
BOOSTING . WATER SUPPLY
FIRE FIGHTING . IRRIGATION
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DRYSDALE & Co. (YOKER) GLASGOW

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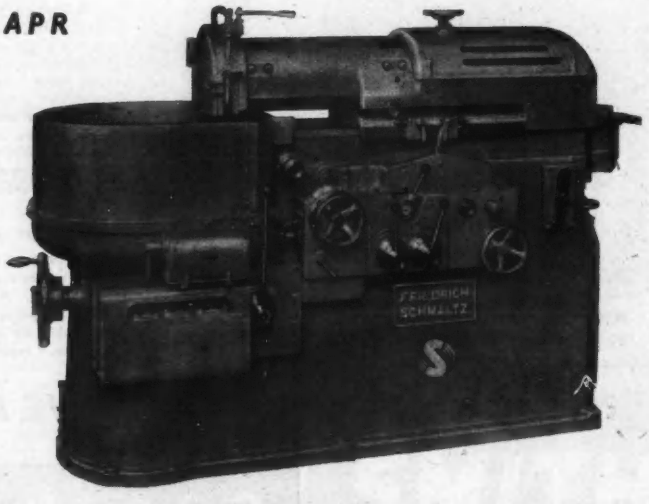
CENTRIFUGAL AND ROTARY PUMPS FOR ALL LAND AND MARINE SERVICES

SCHMALTZ ROTARY SURFACE GRINDERS

● *TYPE APR*



These machines with horizontal spindle and rotary table are especially suitable for the production grinding of rings, discs, plates, etc. Hydraulic drive to spindle traverse. Stepless variation of table speed.

CAPACITY

Model	Dia. of table	Max. grinding height	Dia. of wheel
APR400	15¾in.	4in.	12in.
APR500	19¾in.	4in.	12in.
APR600	23¾in.	6in.	13¾in.
APR700	27½in.	6in.	13¾in.

The SCHMALTZ range also includes: Hydraulic Plain Cylindrical Grinders, Roll Grinders, Vertical Spindle and Piano Type Surface Grinders and Grinders for repair and maintenance of Motor Car & Locomotive parts.

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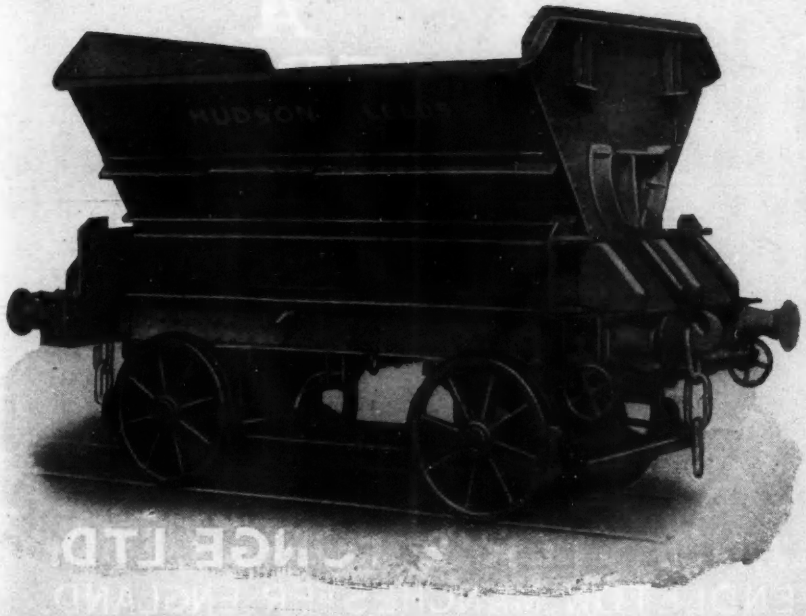

The illustration shows the Hudson Automatic Tip Wagon, 300 c.ft. capacity. Tipping Wagons made in all sizes from 10 to 400 c.ft., to meet customers' conditions.

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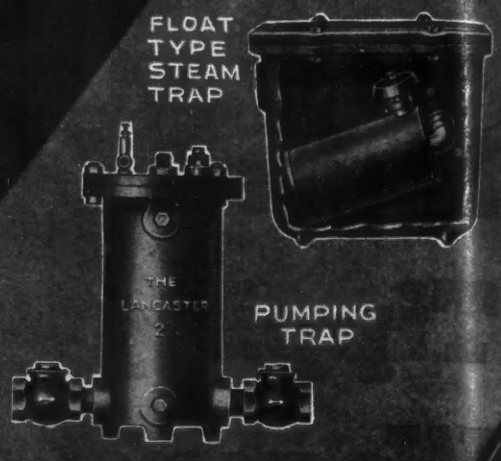

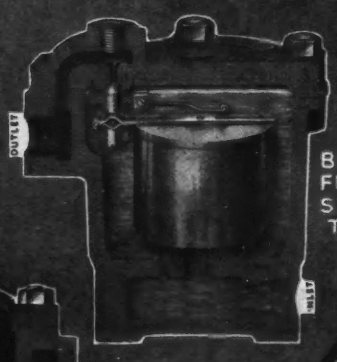

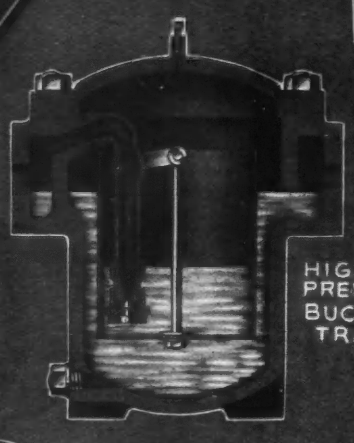

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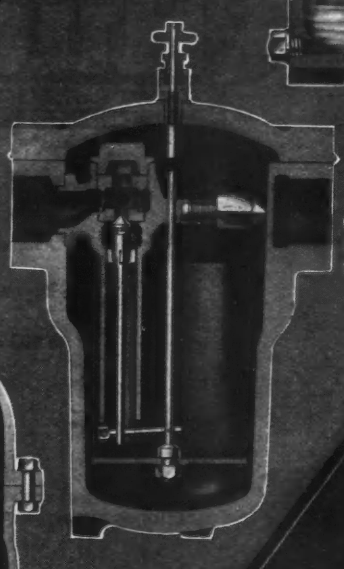

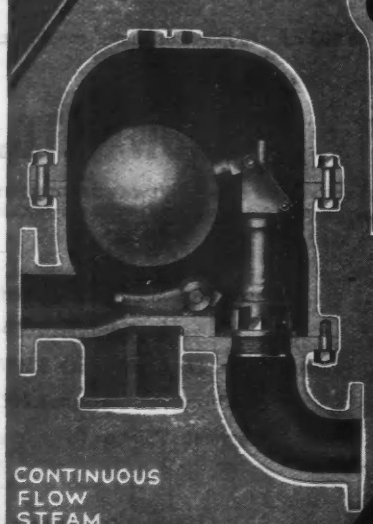

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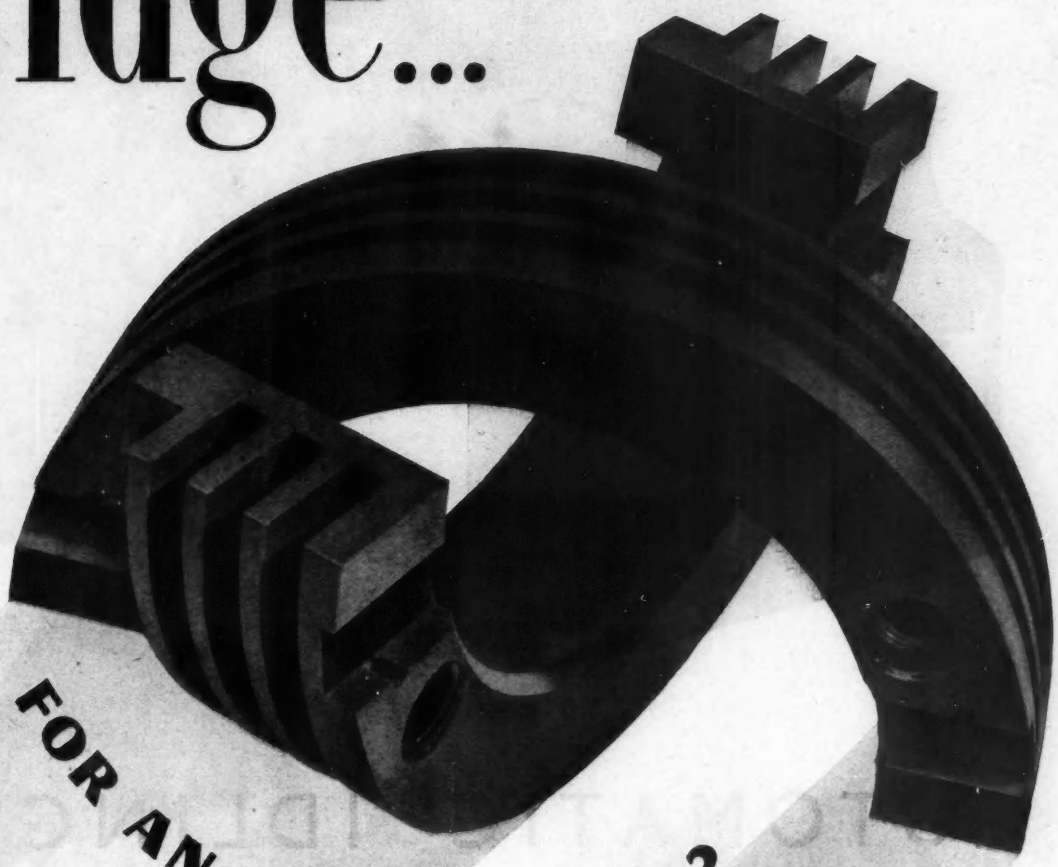

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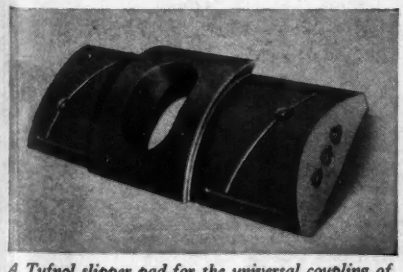
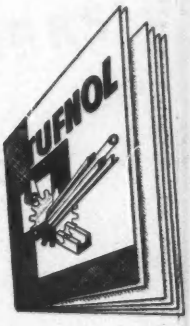


A Tufnol slipper pad for the universal coupling of a rolling mill drive.



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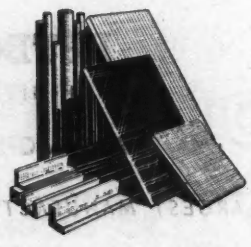

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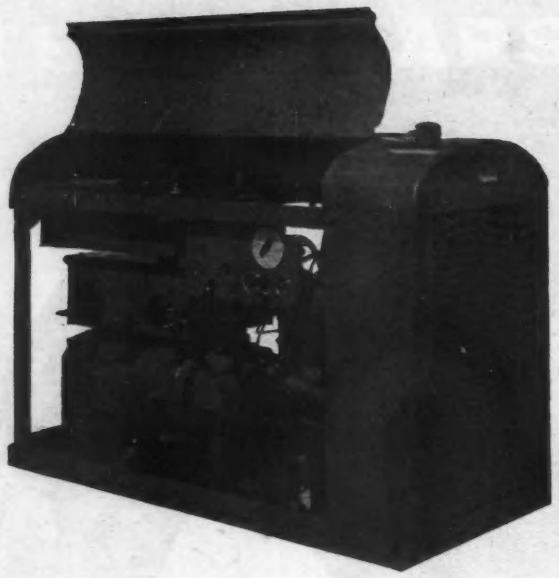

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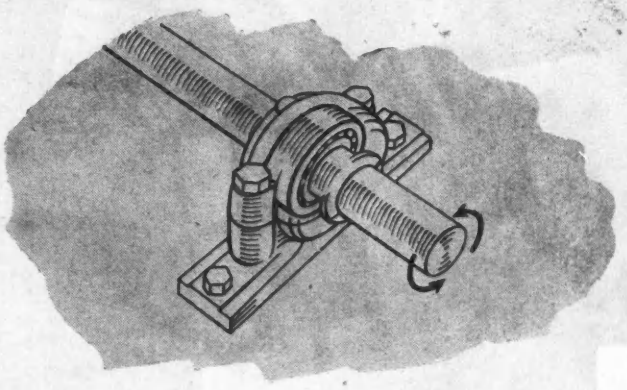
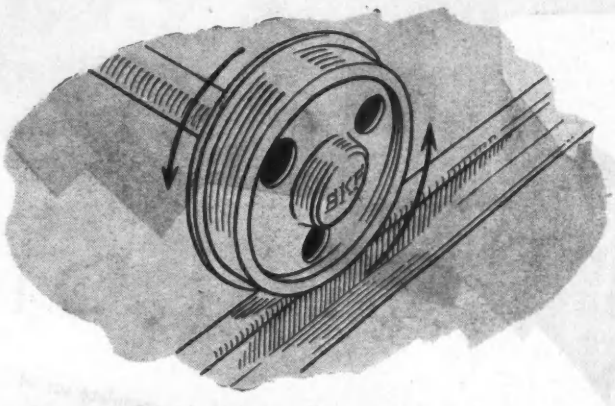


If the shaft rotates, the inner ring of the bearing should have a tight fit on the shaft.



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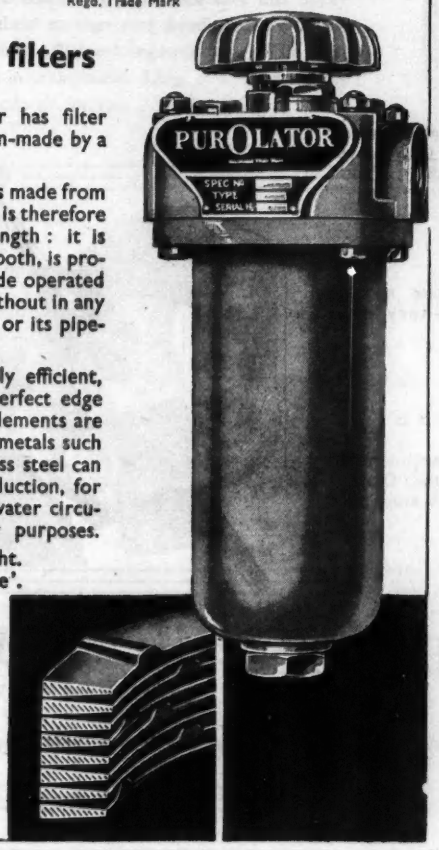

Exaggerated view of part of filter element.

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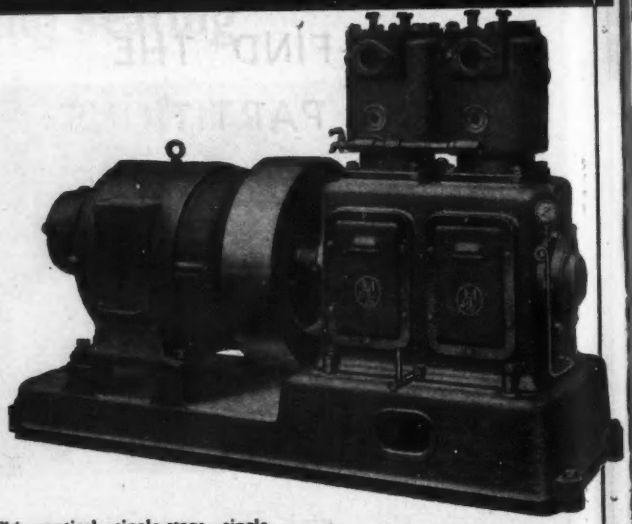

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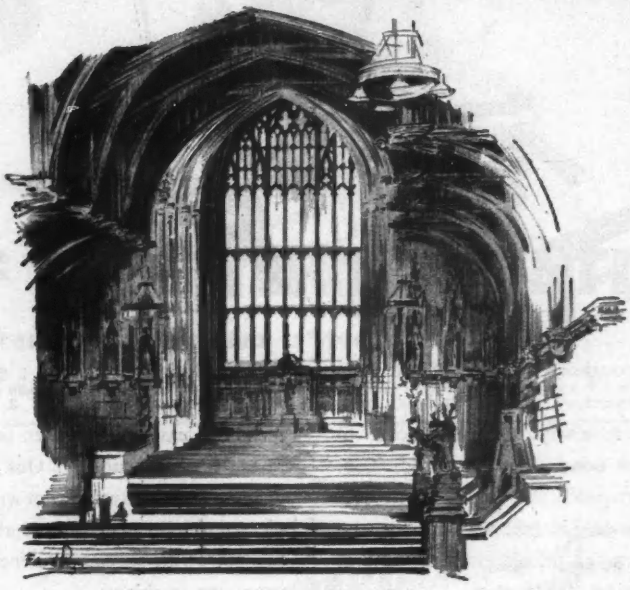

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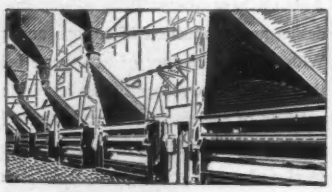

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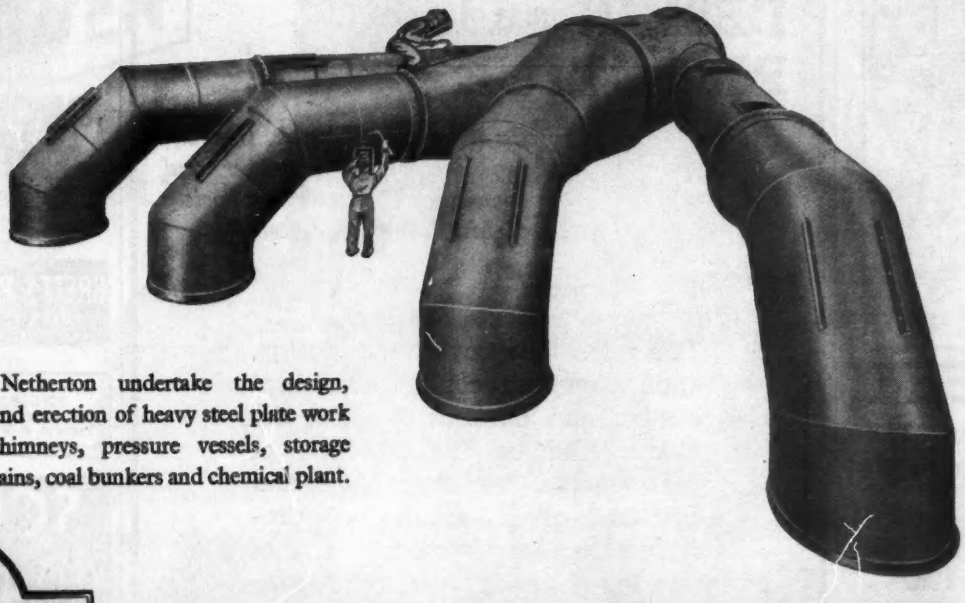

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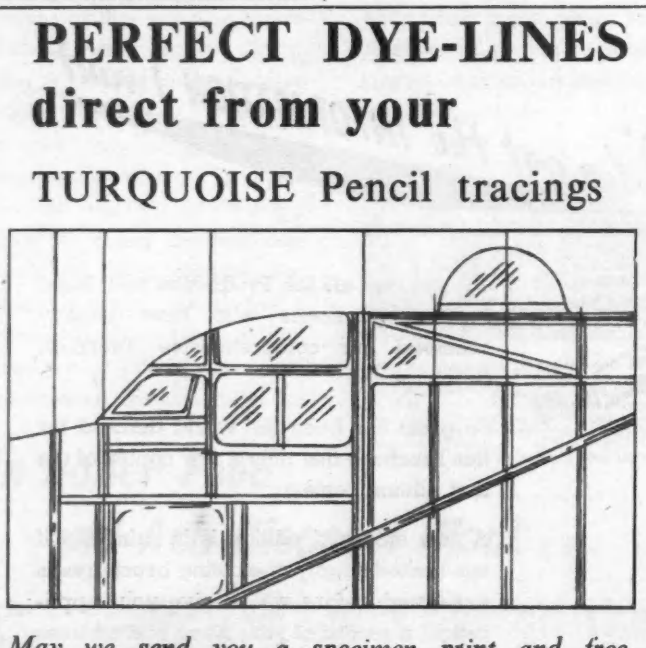

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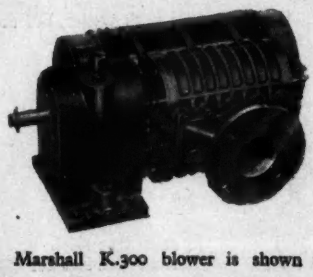

The Marshall K.300 blower is shown fitted with intake filter/silencer and delivery manifold. It can be driven by direct coupling to electric motor etc., or through pulleys and belting.

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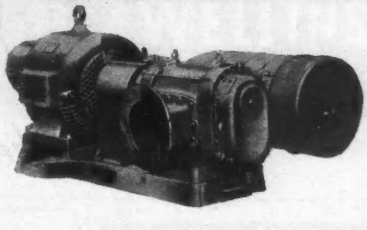

A larger Marshall blower type M.1500, fitted with filter/silencer and delivery manifold, is shown mounted on baseplate complete with electric motor.

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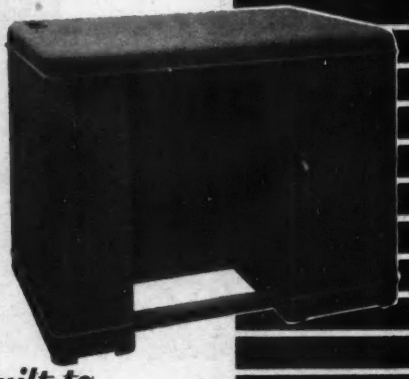

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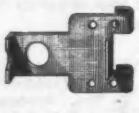

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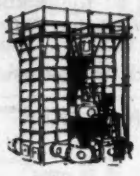

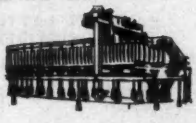

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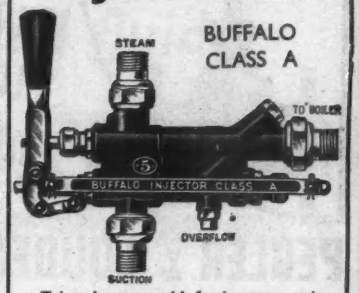

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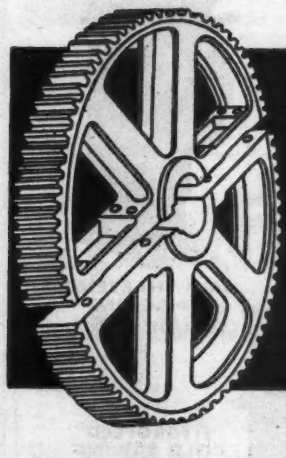

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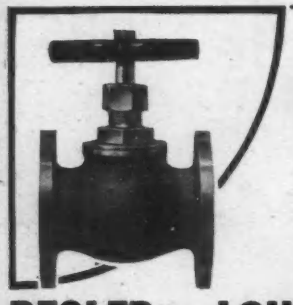

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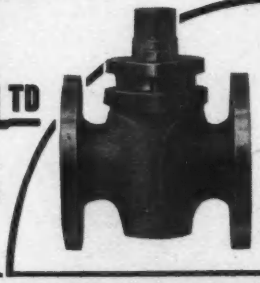

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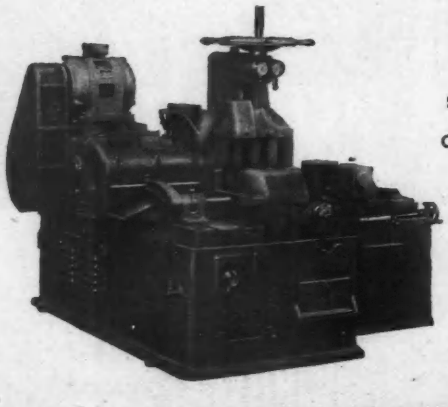

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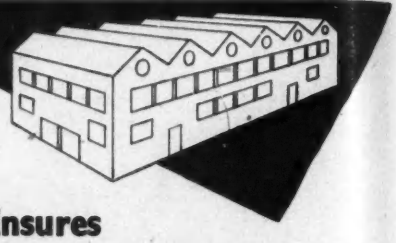

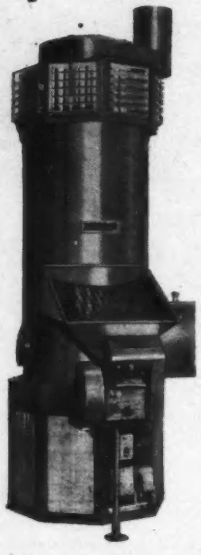

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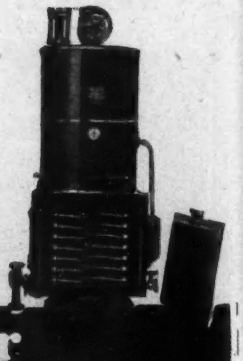

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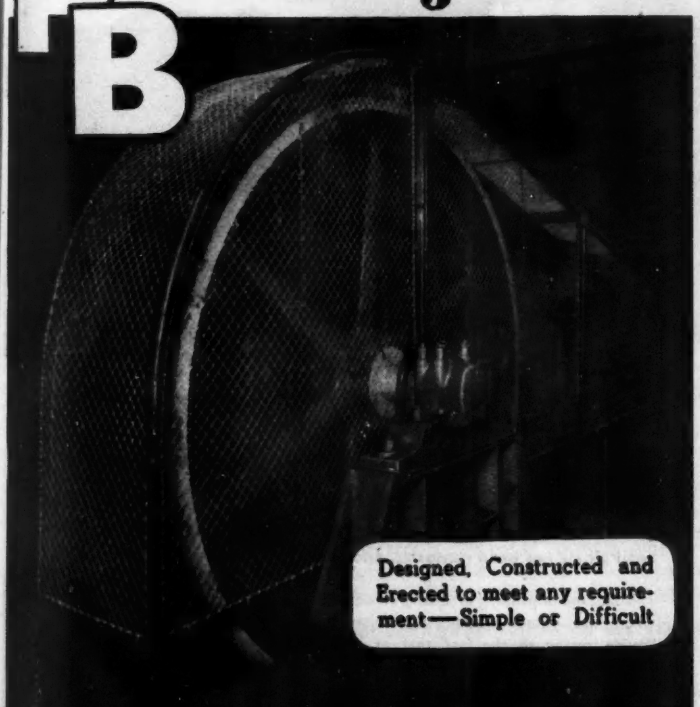

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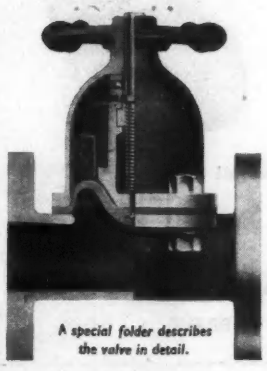

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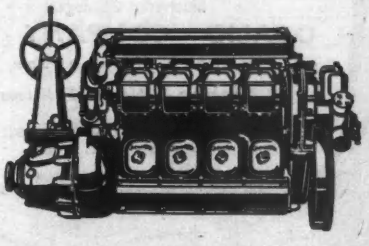

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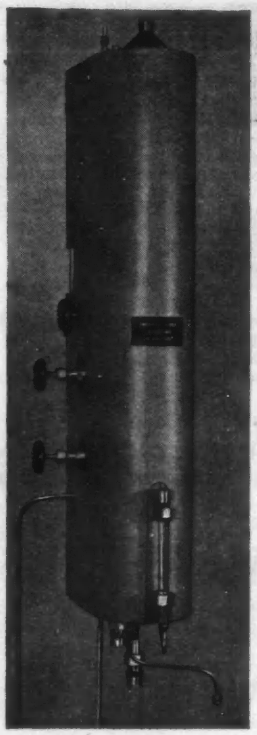

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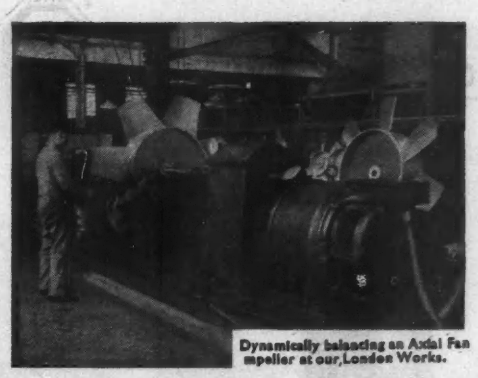

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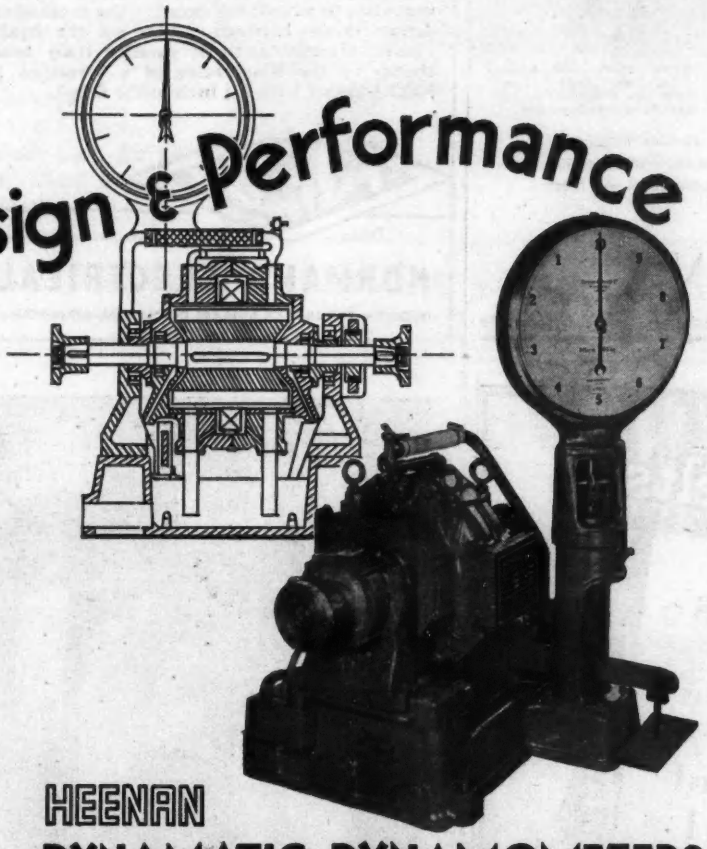

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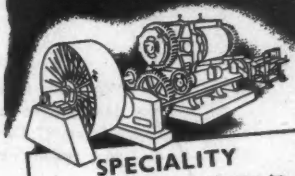

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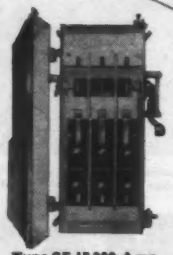
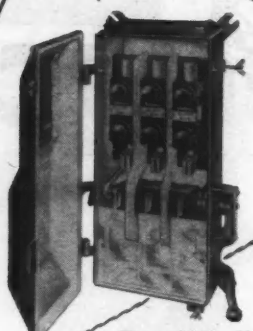


Type SF.15 200-Amp. inverted pattern "Scrutact" Switch fuse arranged to receive feeder cable at top.



Type SF.15 300-Amp. "Scrutact" Switch-fuse with switch below fuses—standard arrangement.

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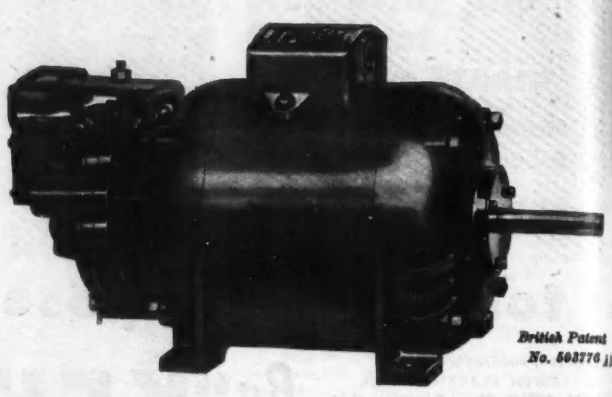

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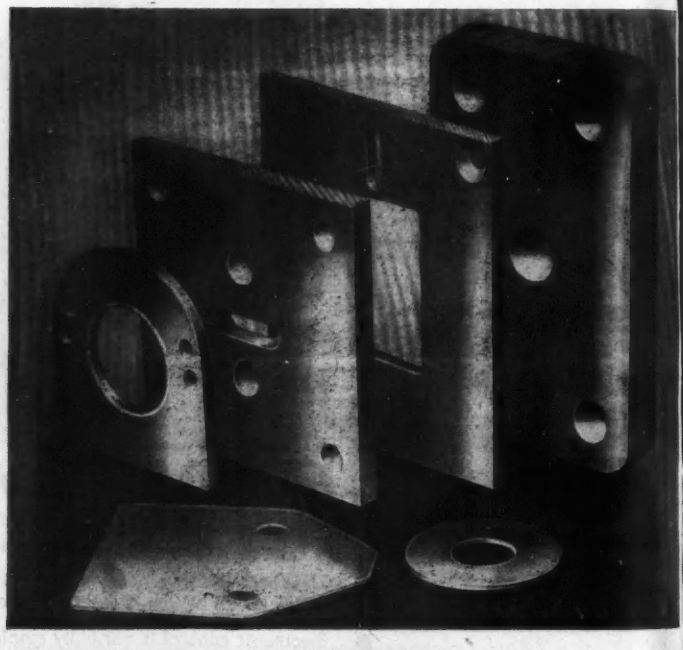

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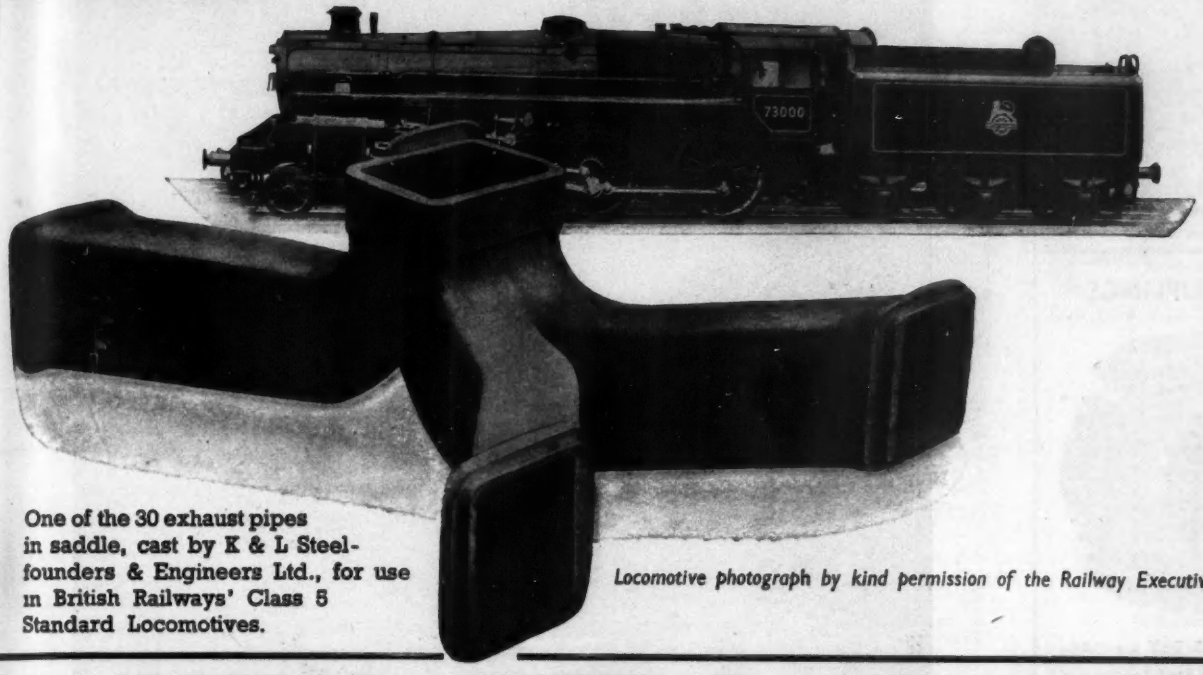

One of the 30 exhaust pipes in saddle, cast by K & L Steelfounders & Engineers Ltd., for use in British Railways' Class 5 Standard Locomotives.

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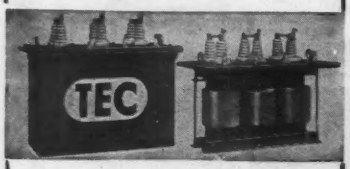

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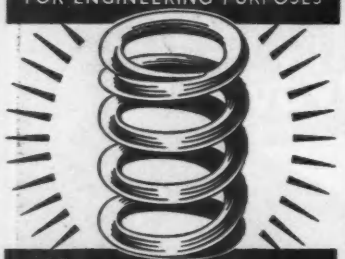

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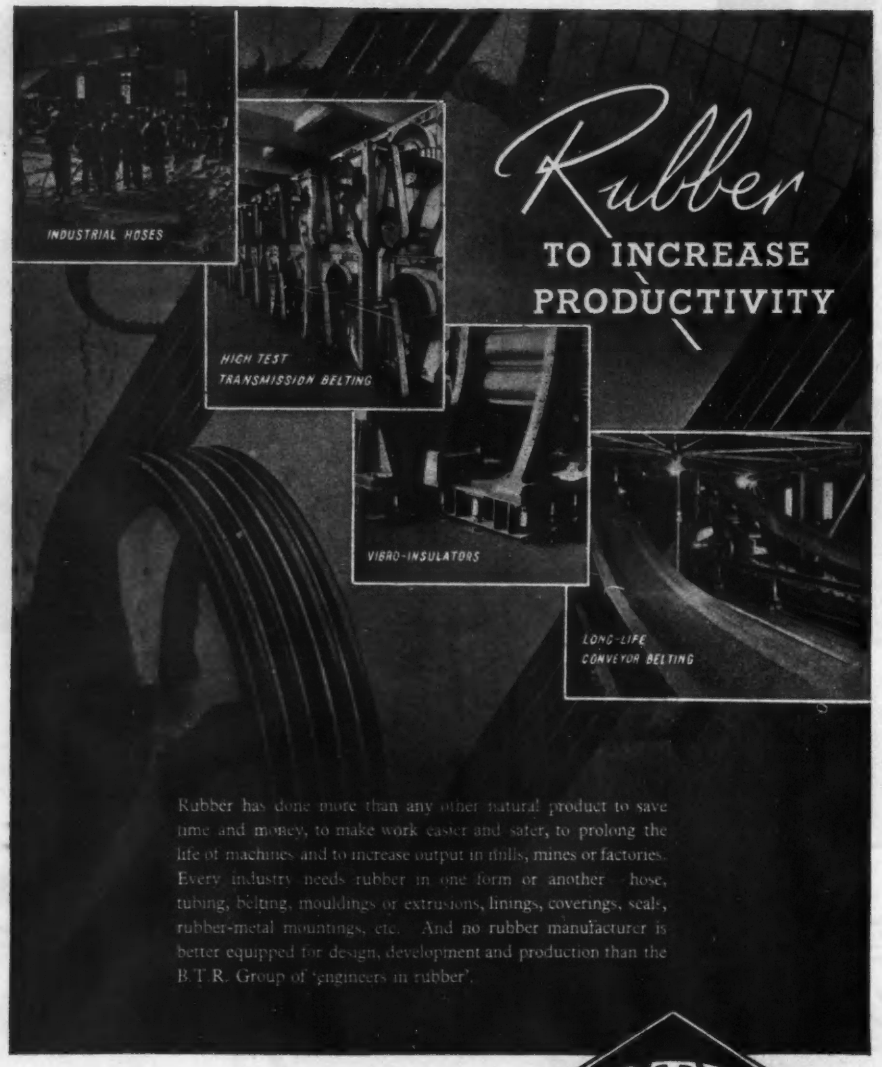

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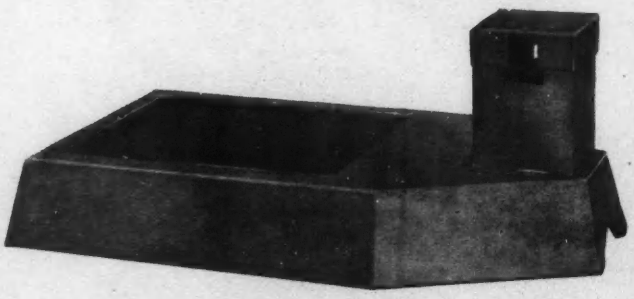

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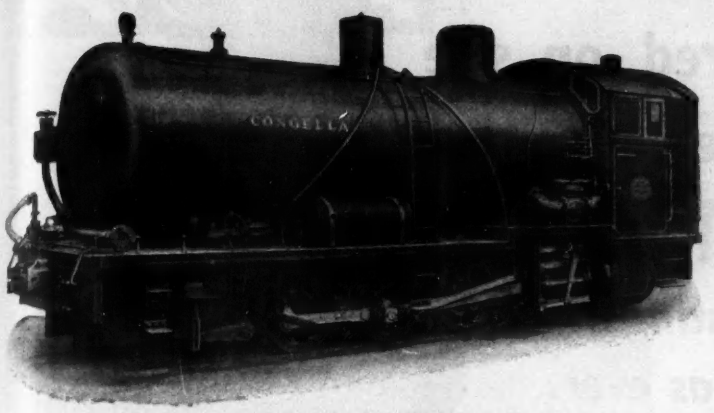

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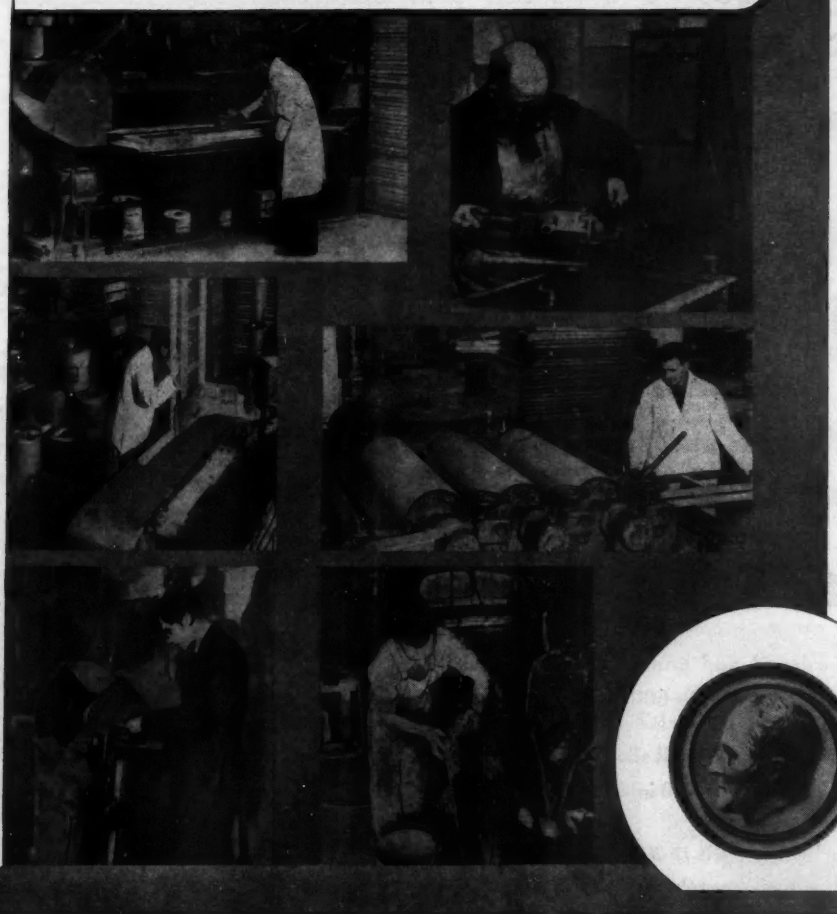

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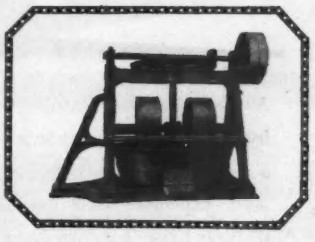

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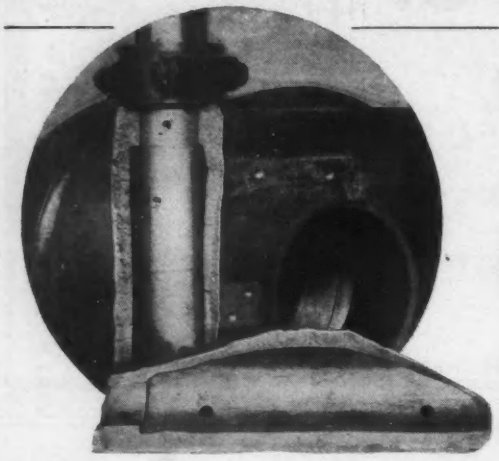

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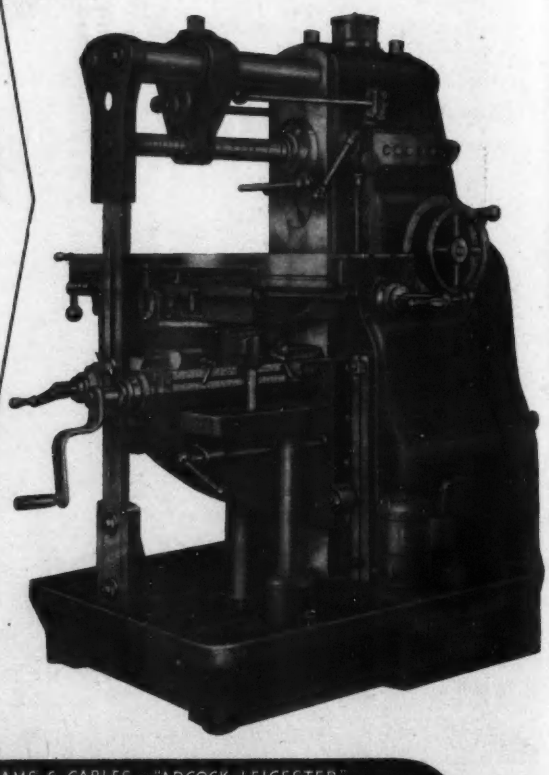

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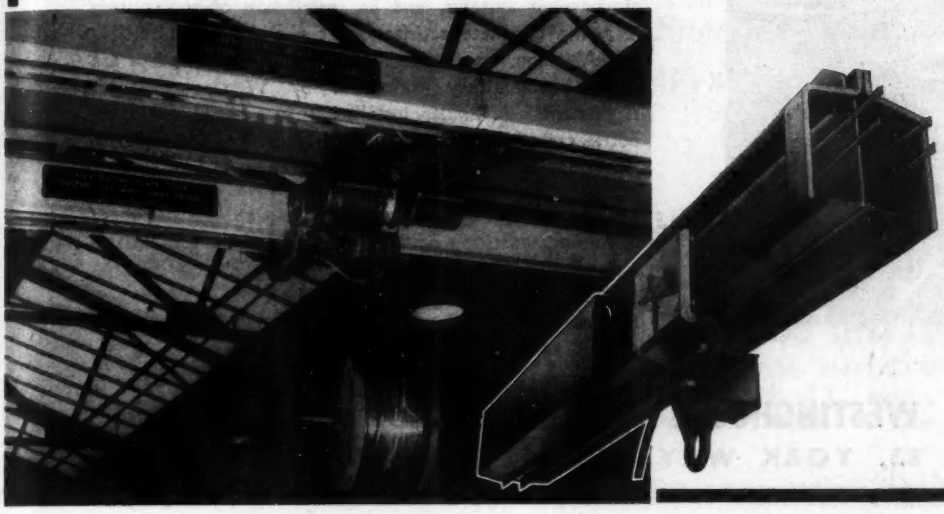

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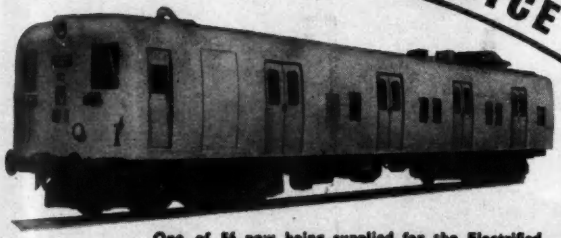

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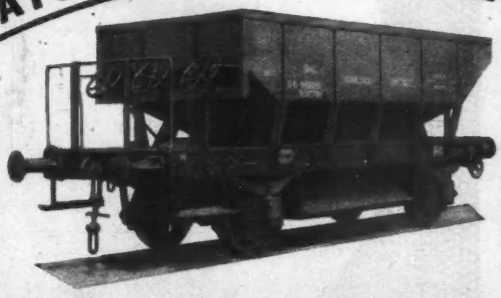

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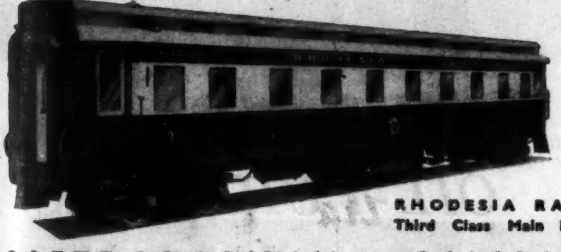

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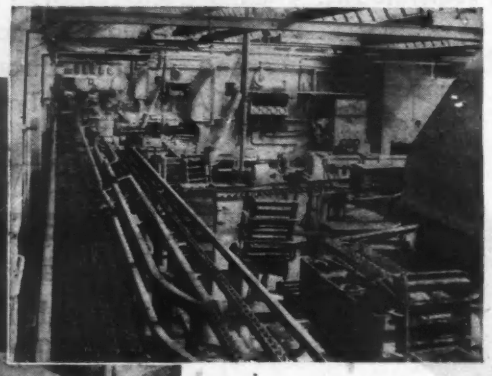

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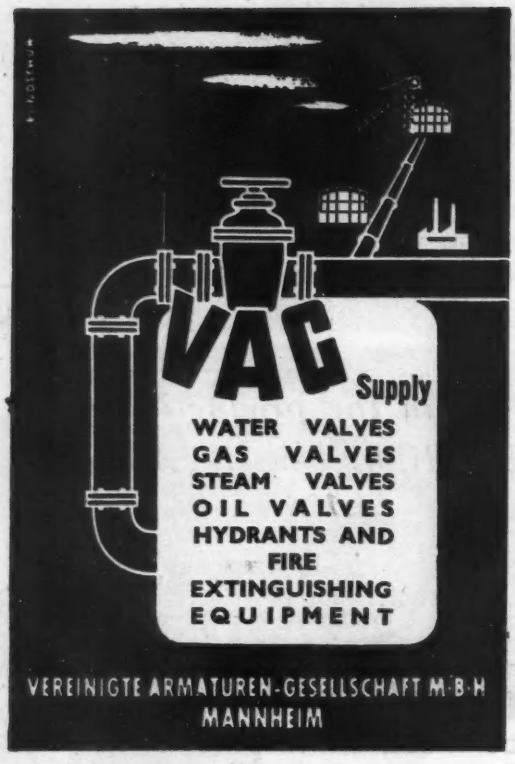

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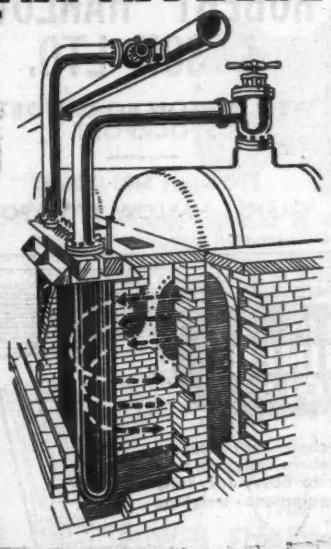

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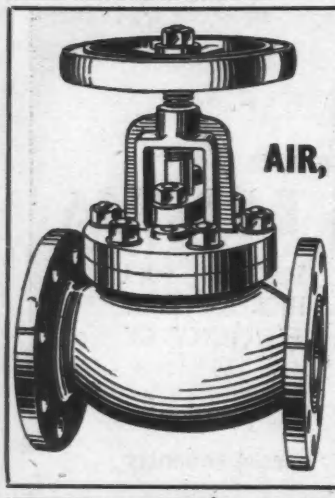

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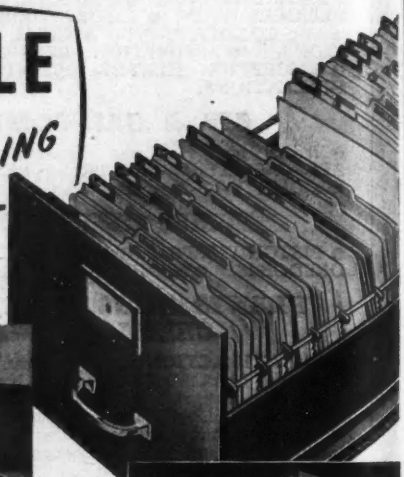

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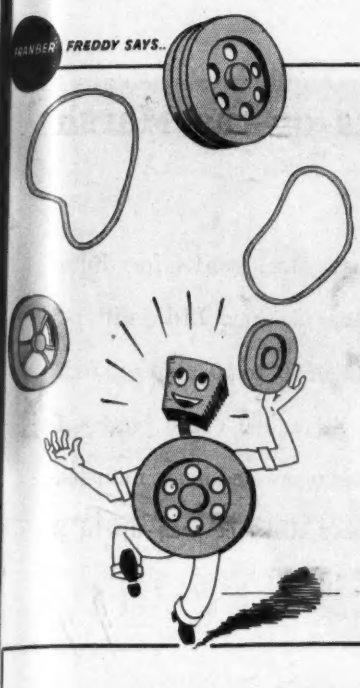

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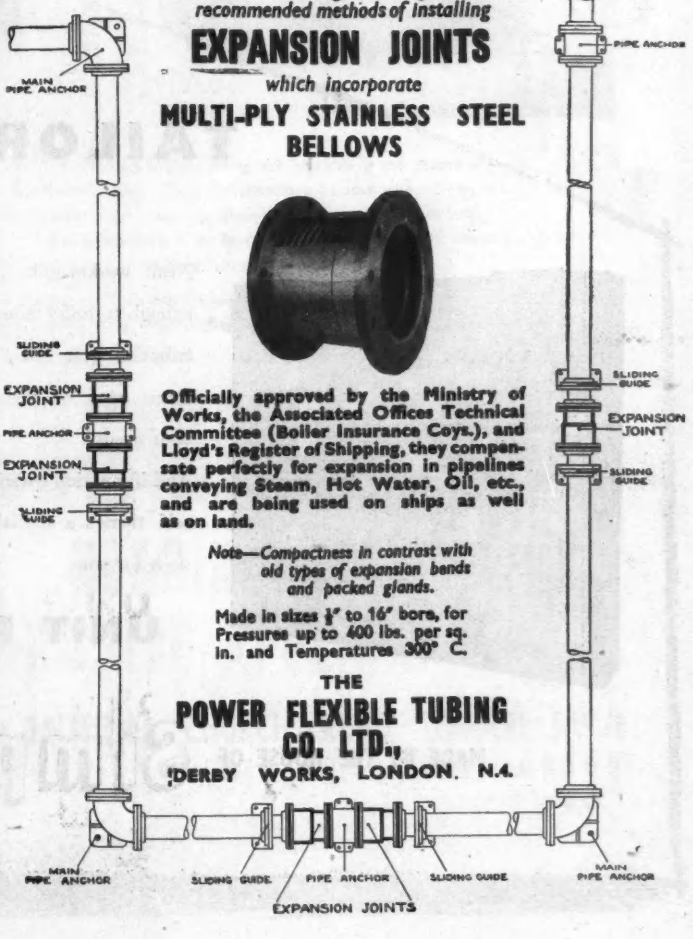

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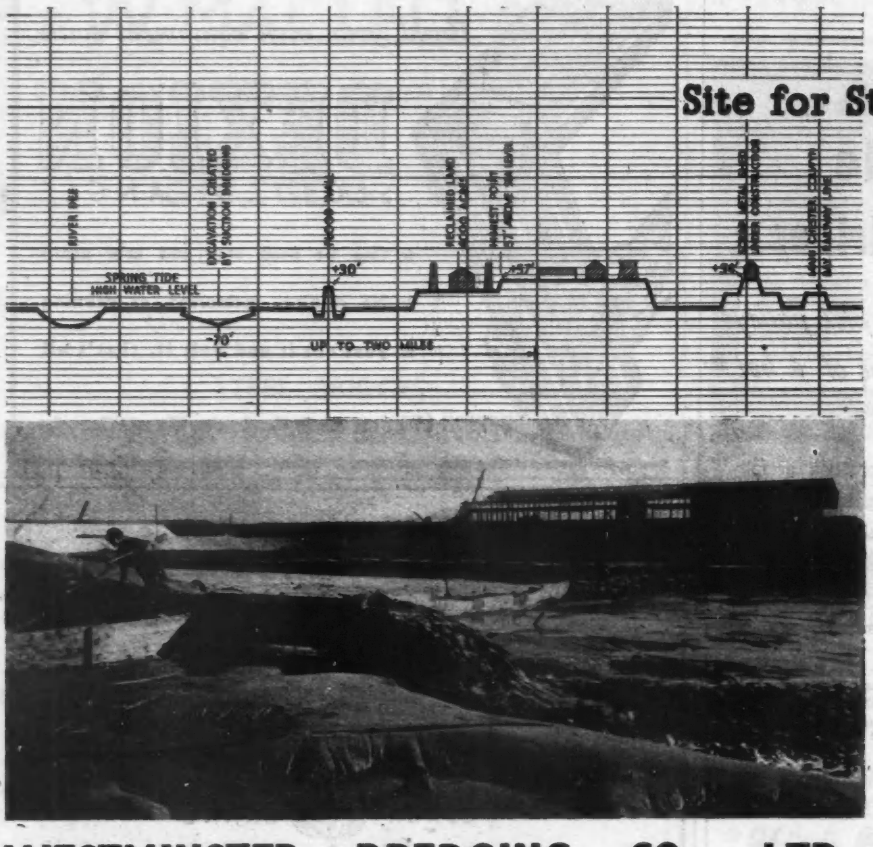

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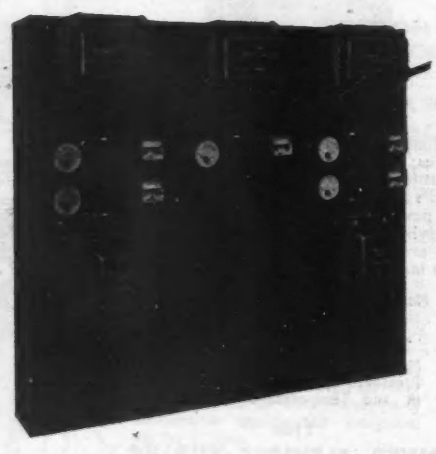

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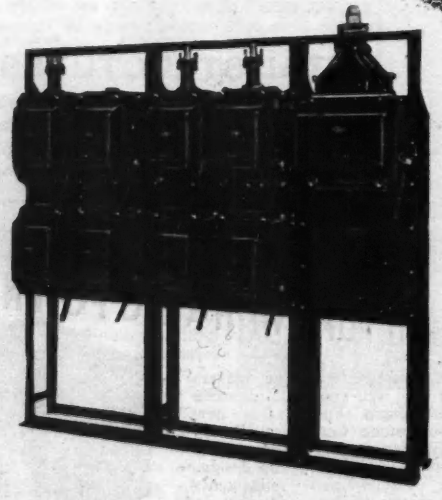

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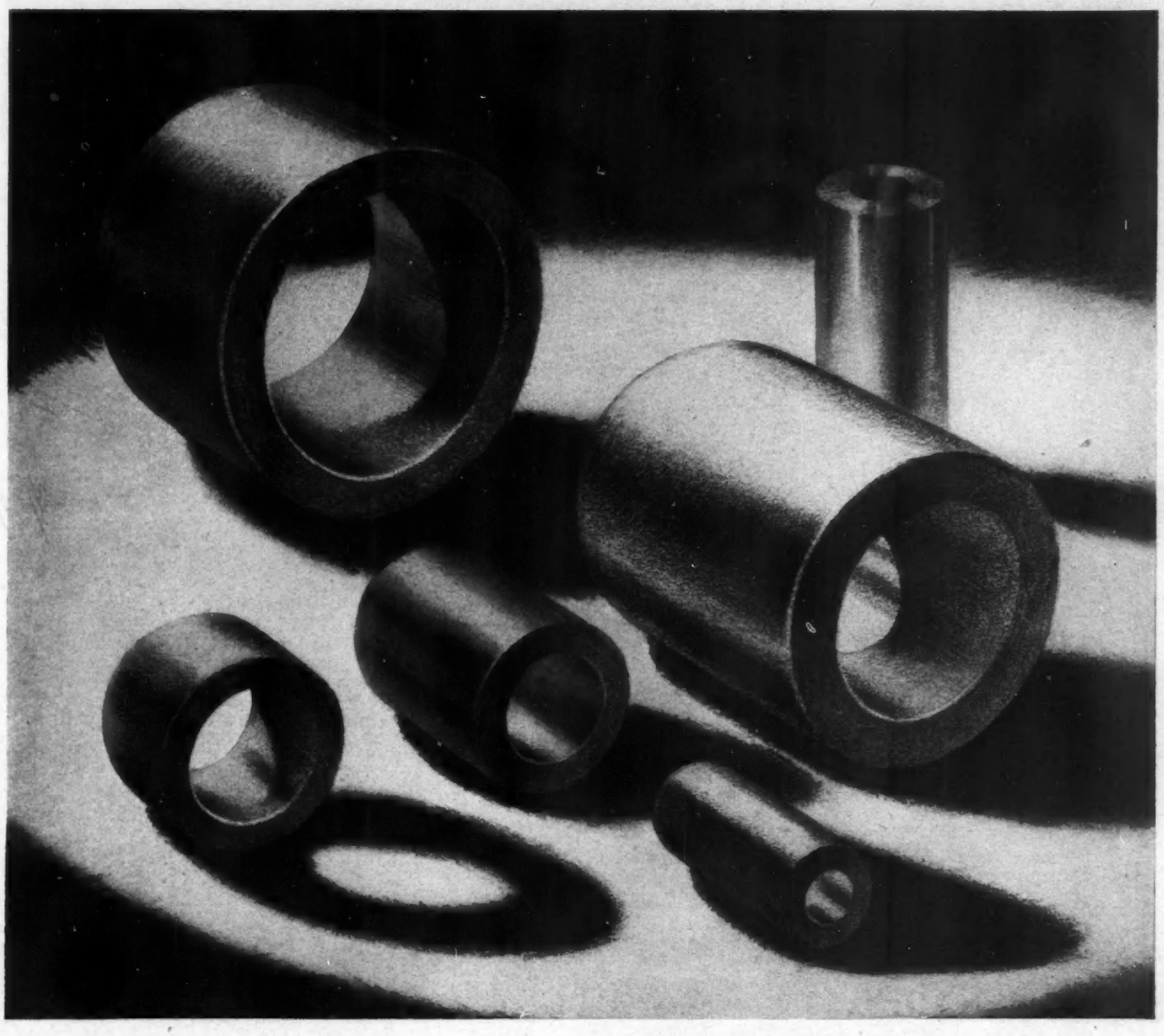

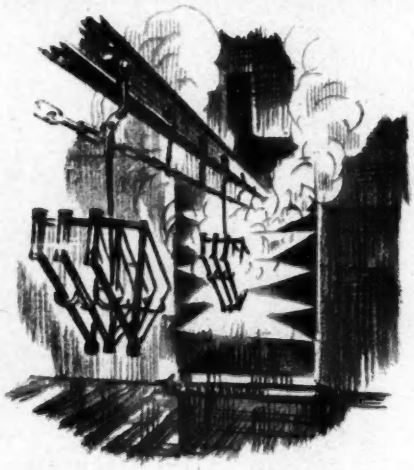

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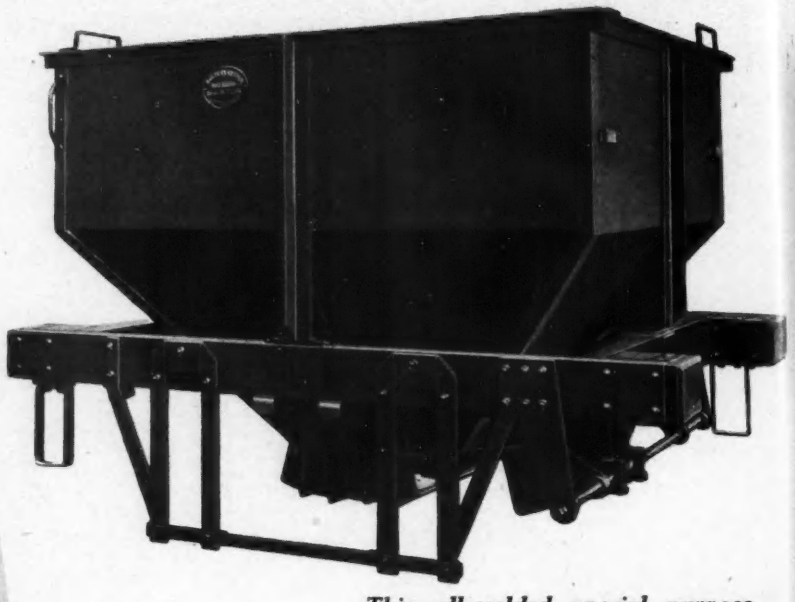
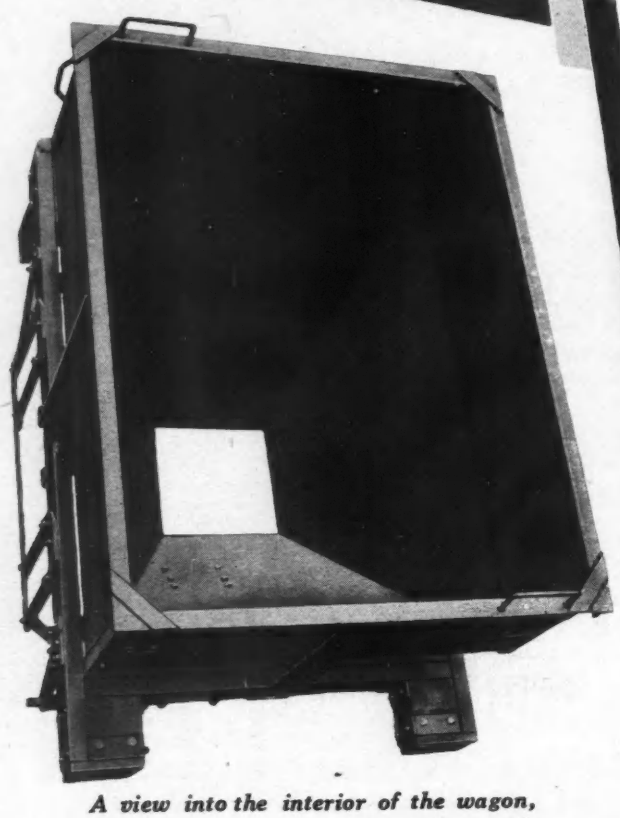


This all-welded special purpose coal hopper wagon of 5 tons capacity is for gas works use.



A view into the interior of the wagon, showing the robust construction, with doors open.

This special purpose wagon illustrated is typical of the many manufactured by Butterley to individual specification. The Butterley Company has long experience in the design and fabrication of railway wagons in all-welded or riveted-steel construction and in wood, to meet customer's own or standard requirements.

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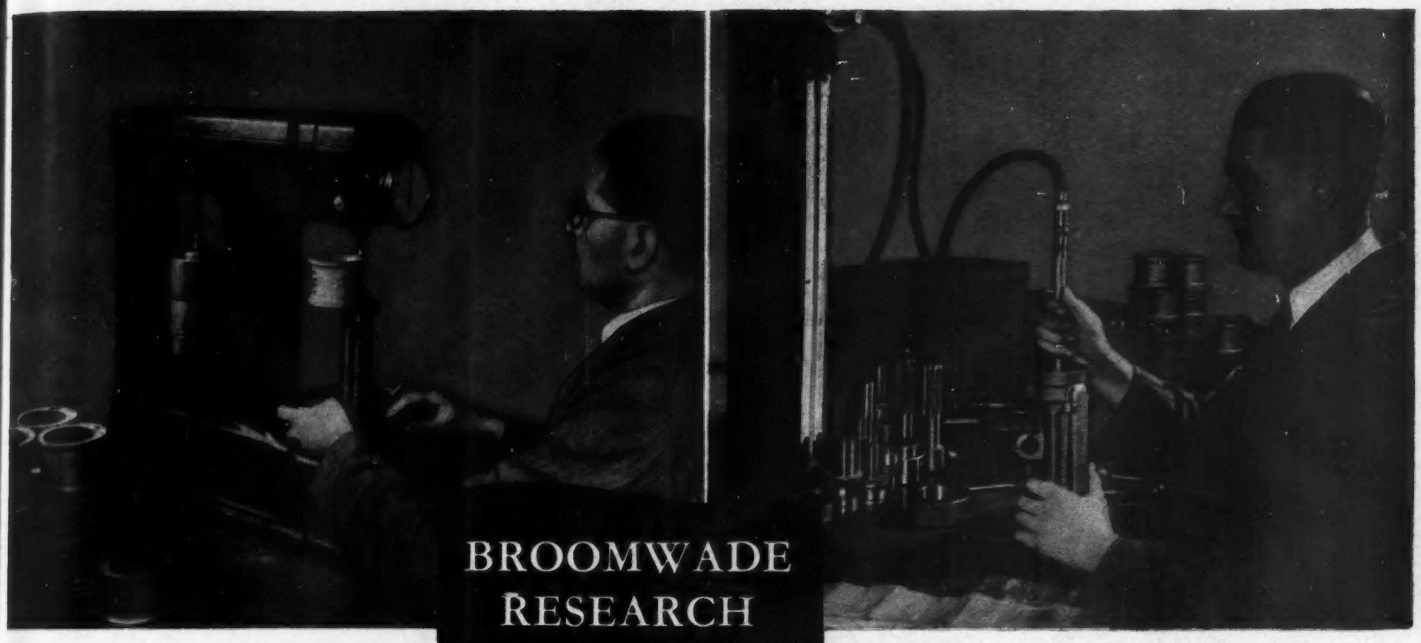

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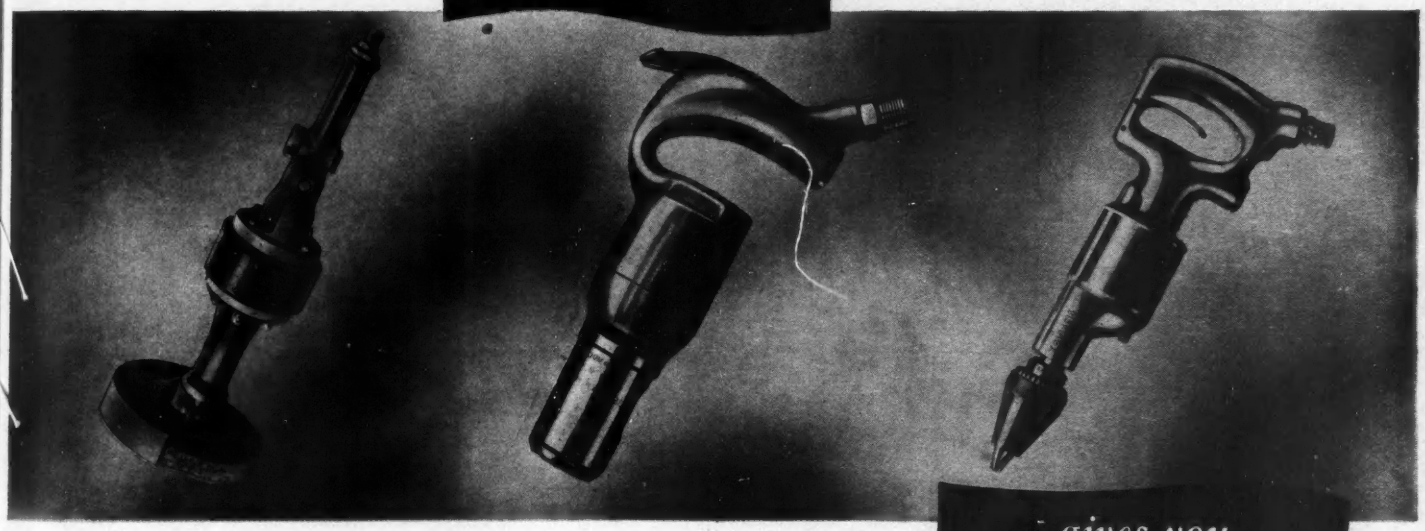

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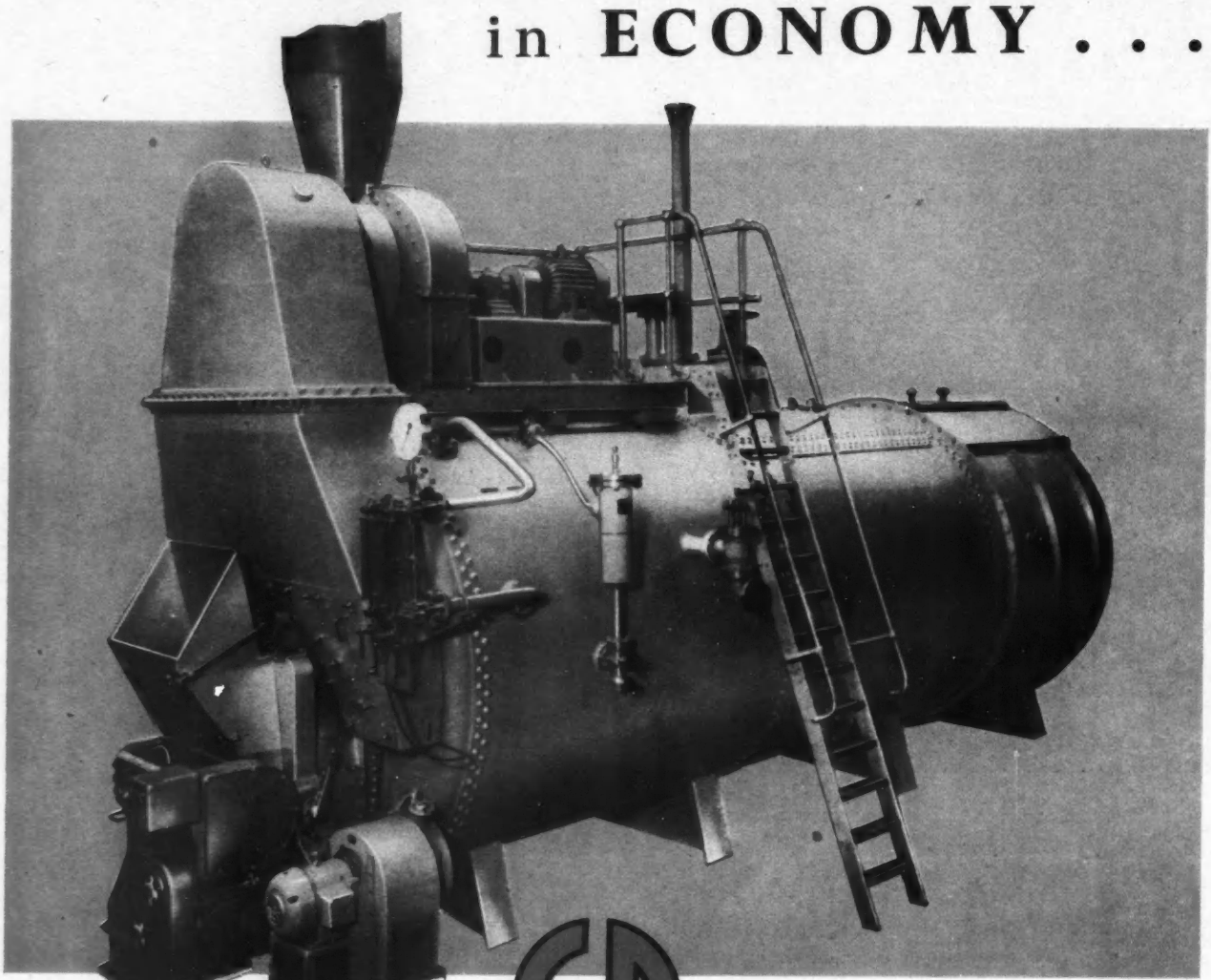

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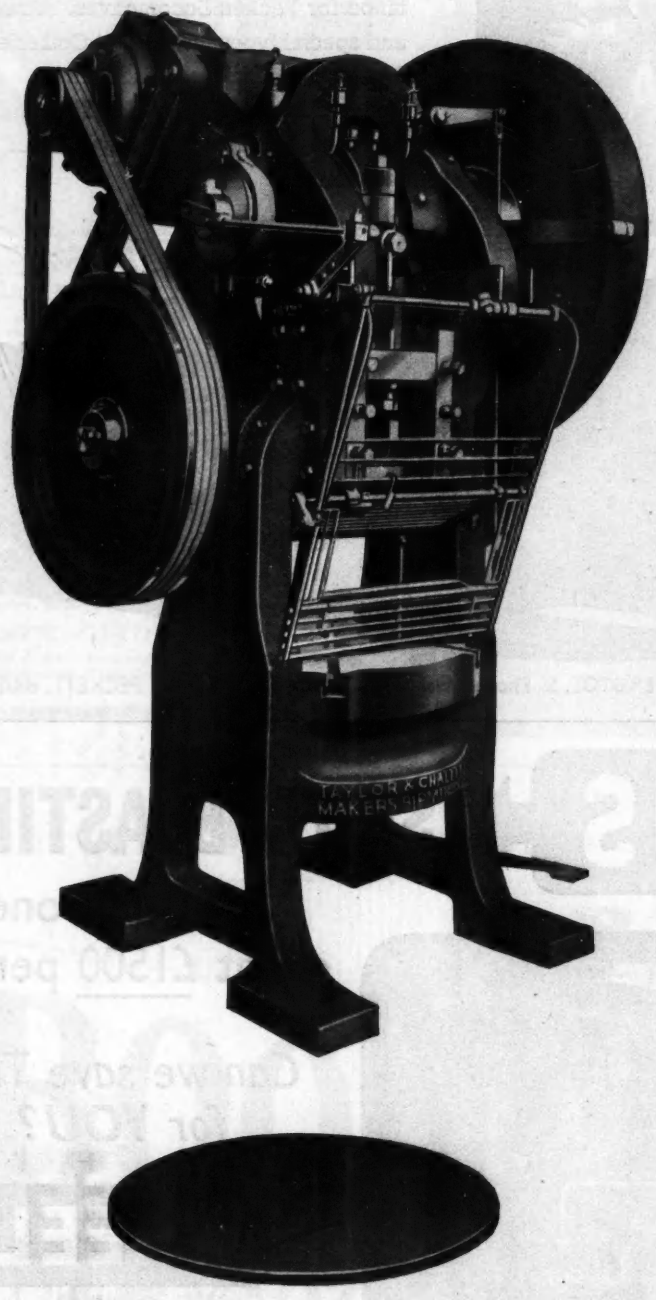

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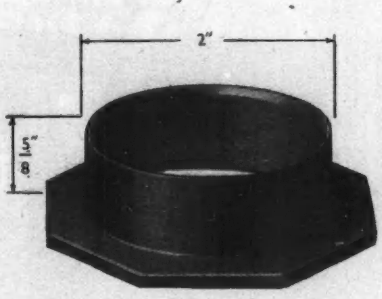

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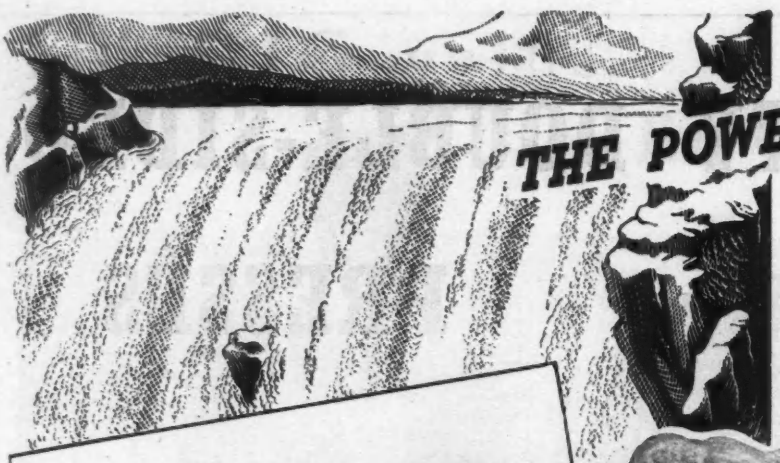

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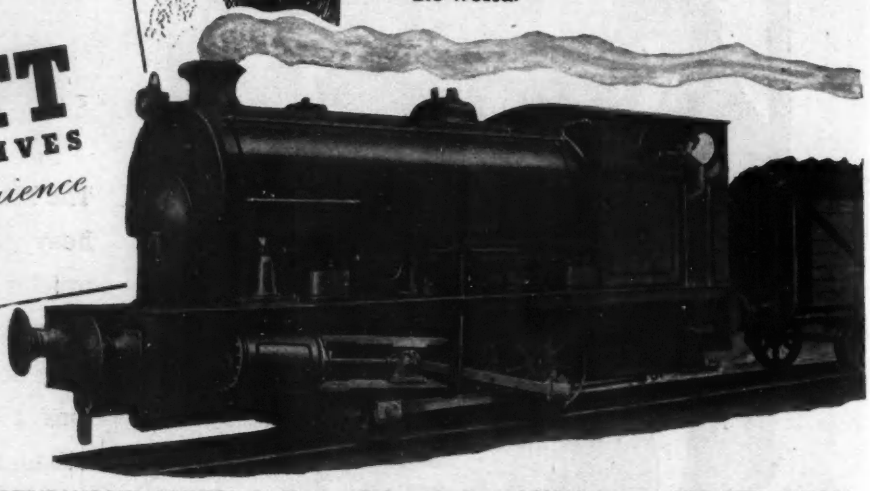

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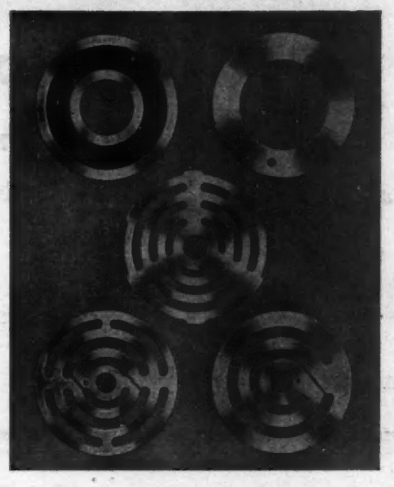

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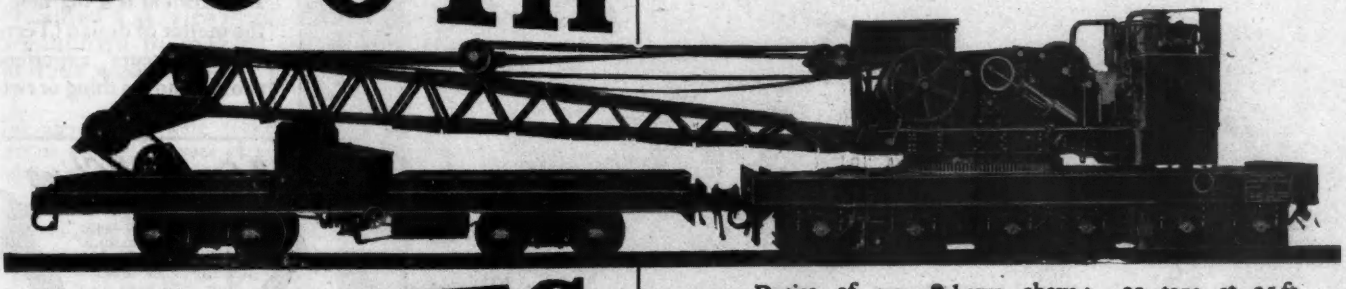

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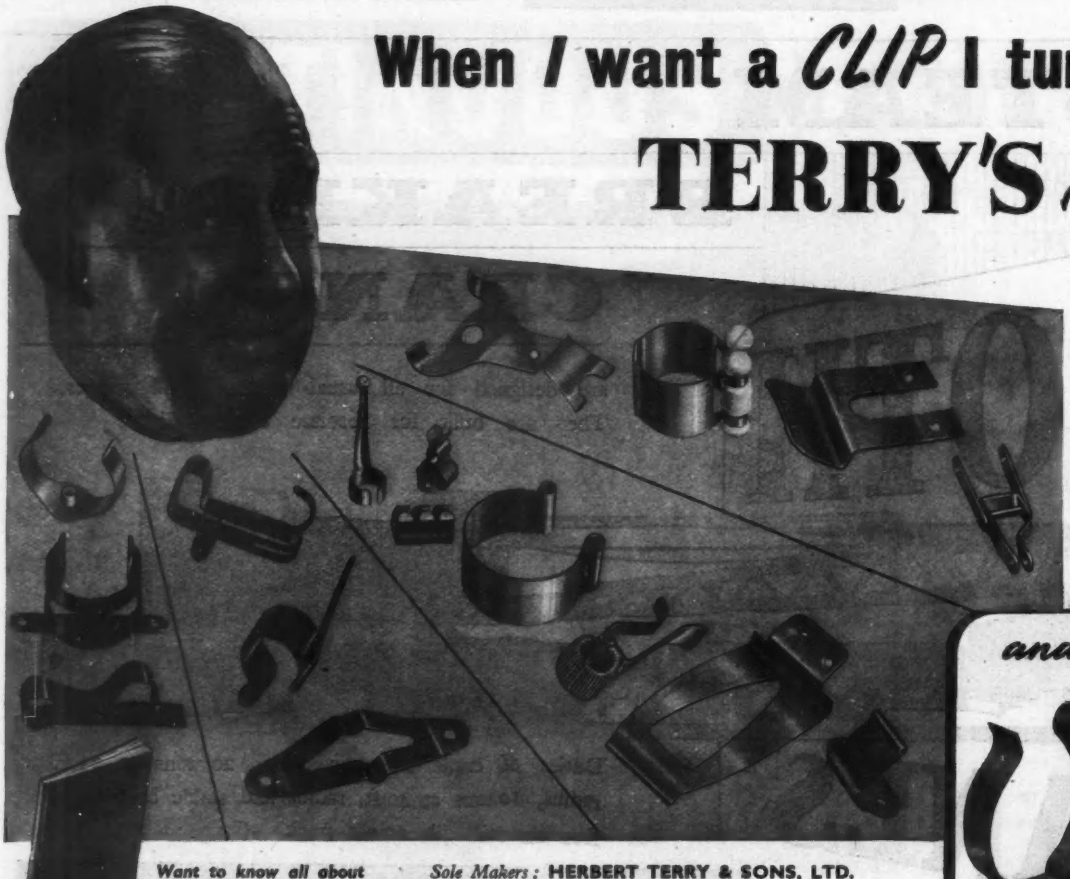

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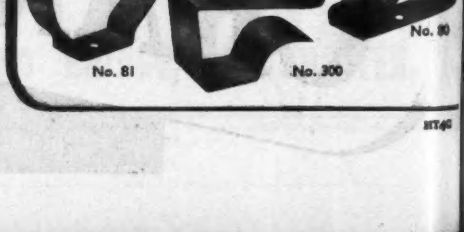

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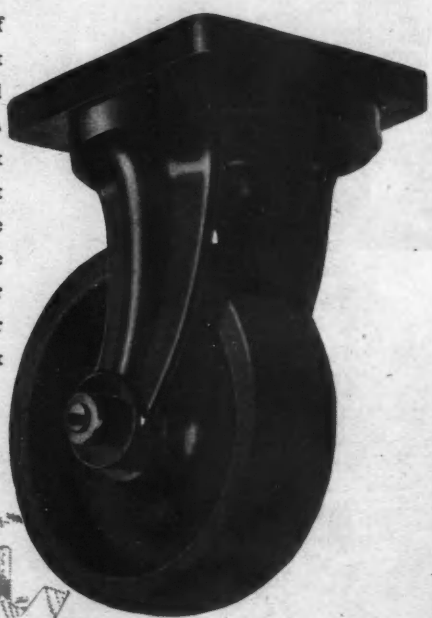

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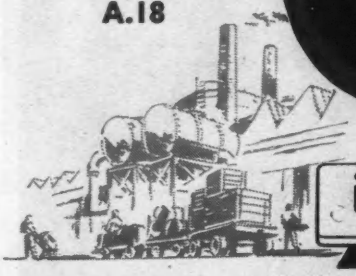

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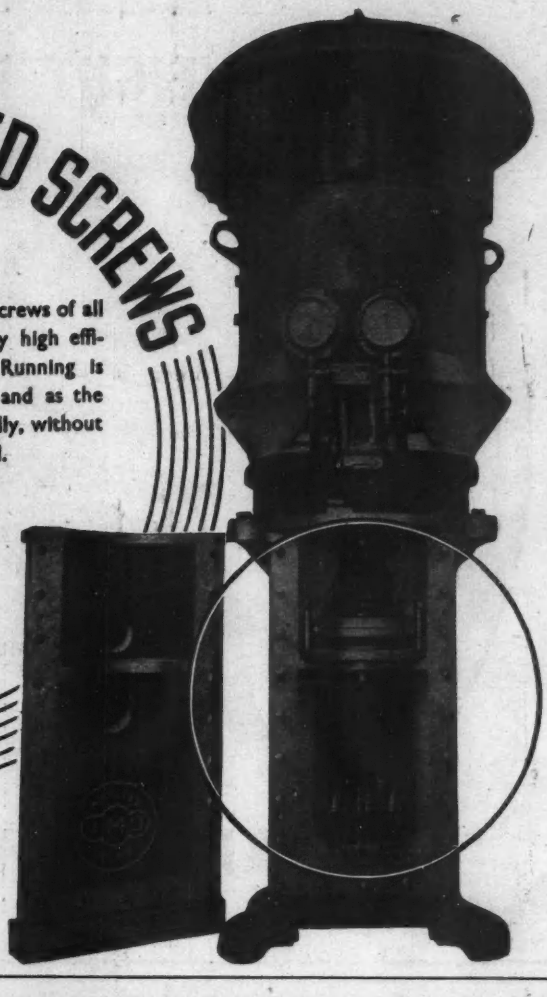

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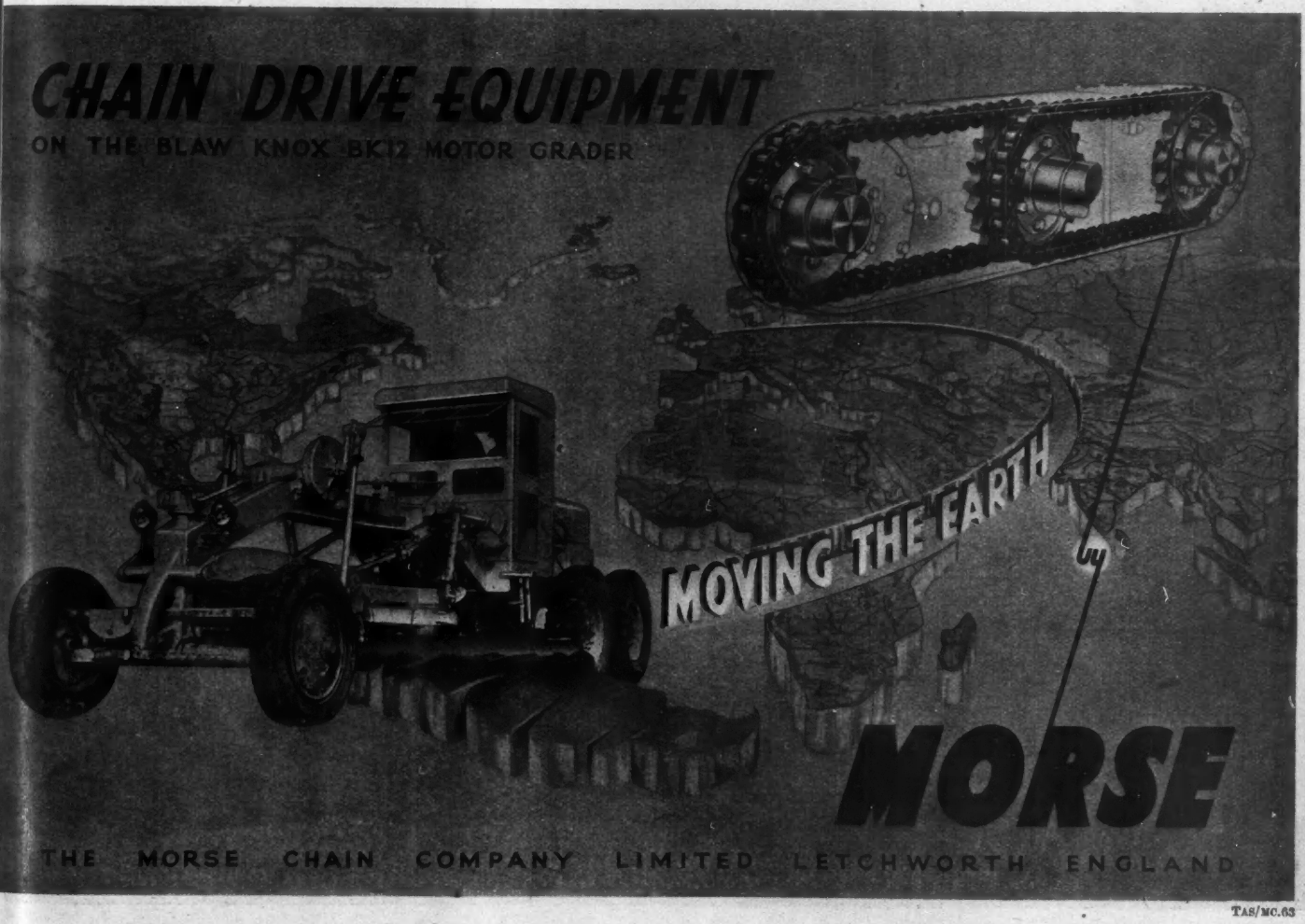

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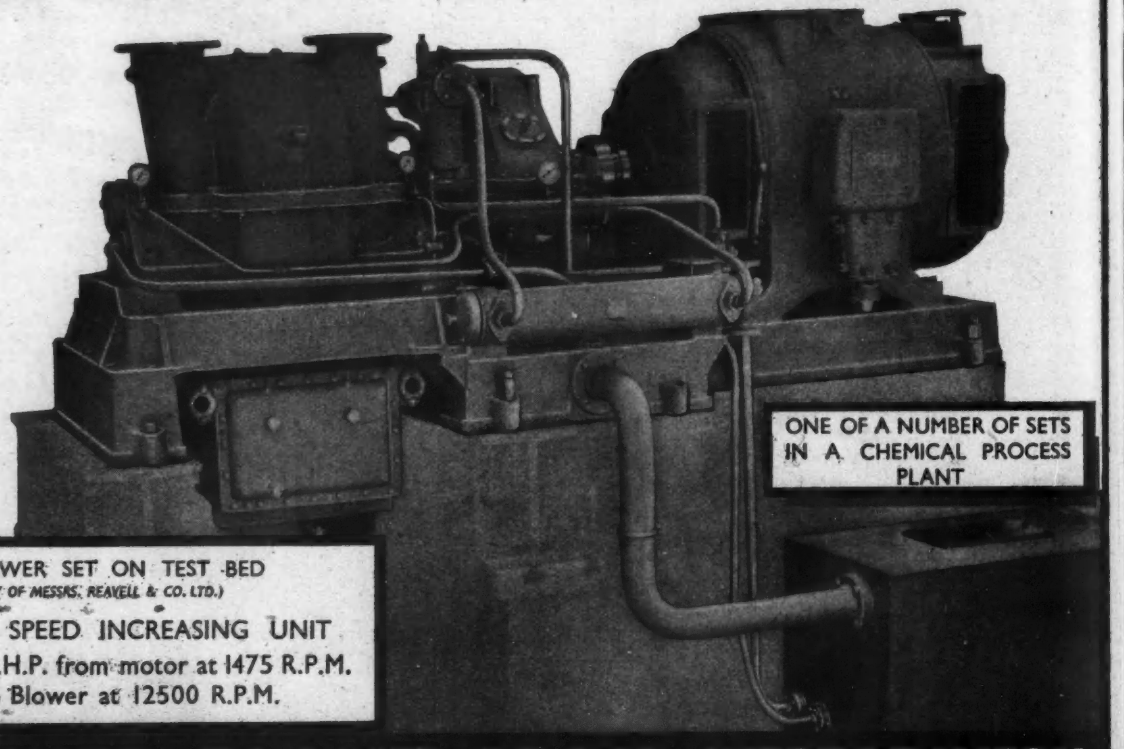

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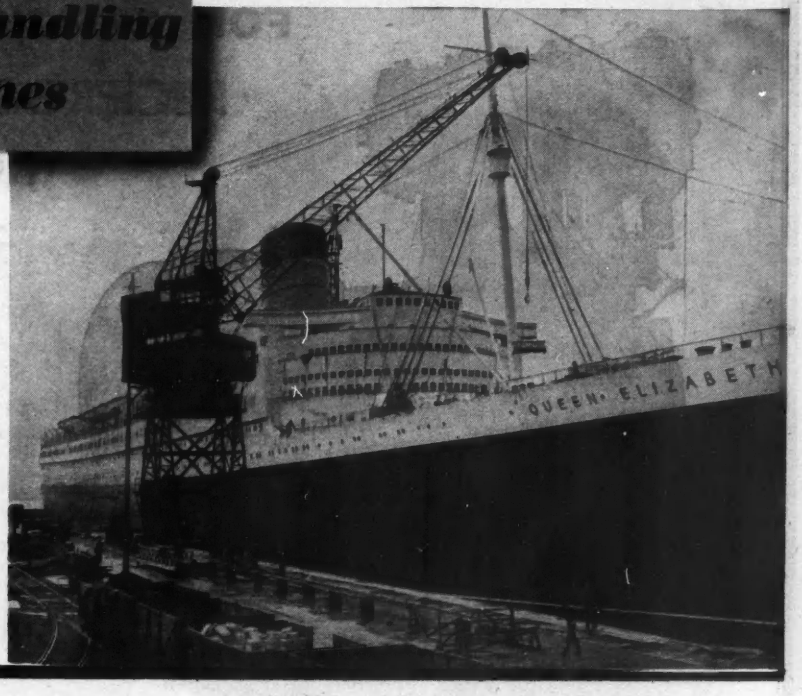

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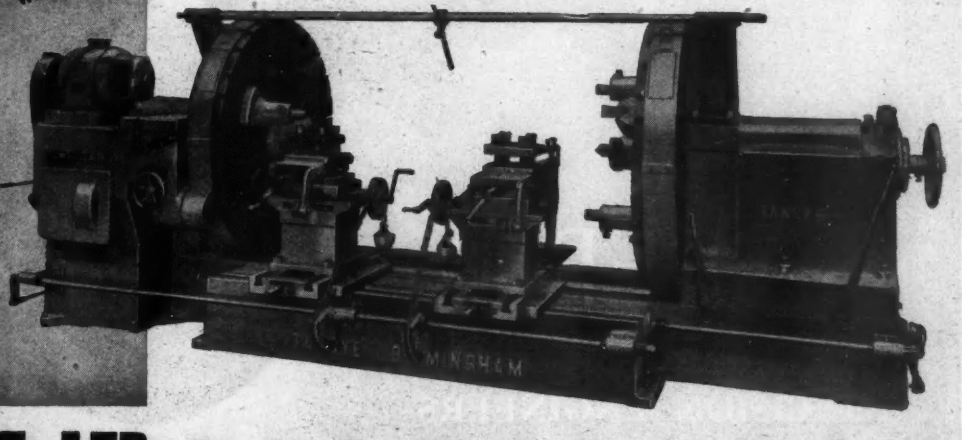

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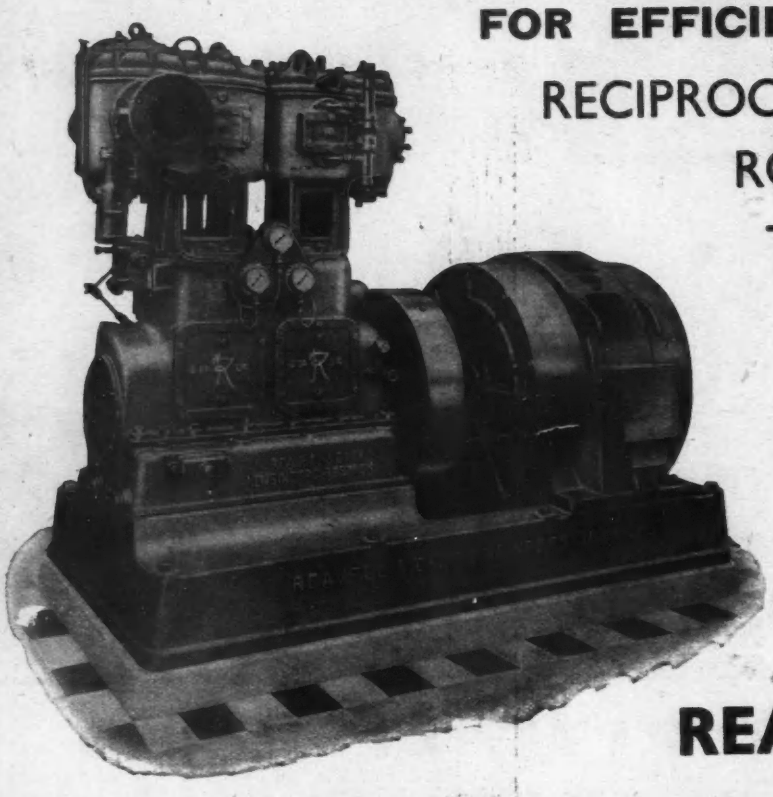

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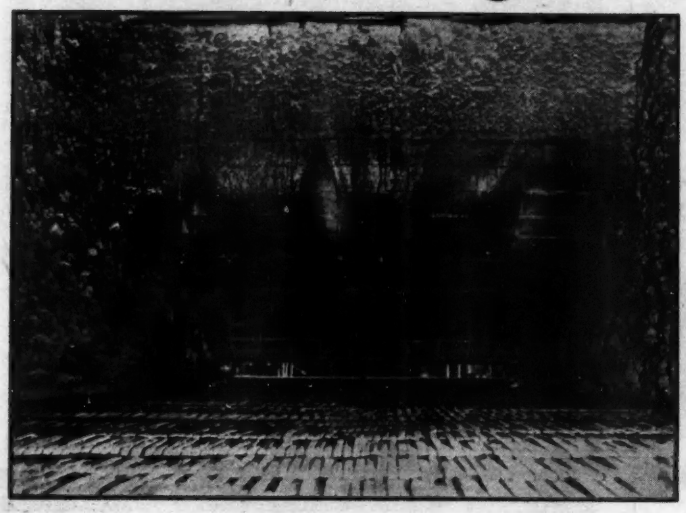

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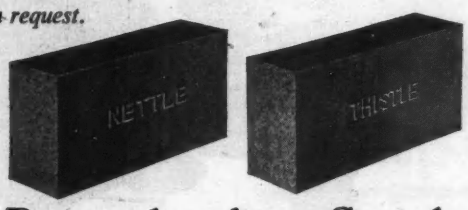

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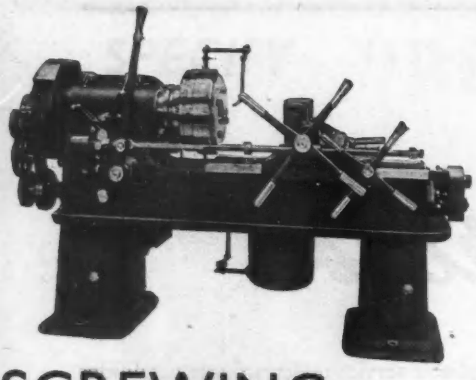

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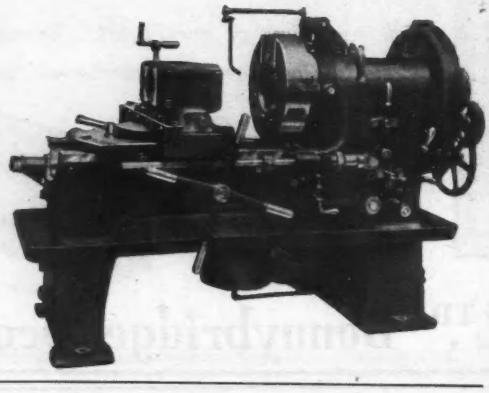

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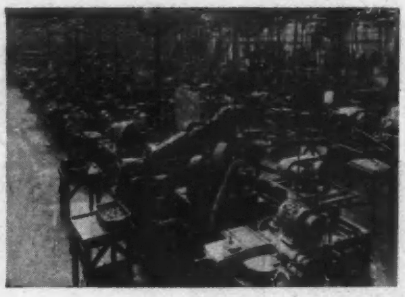

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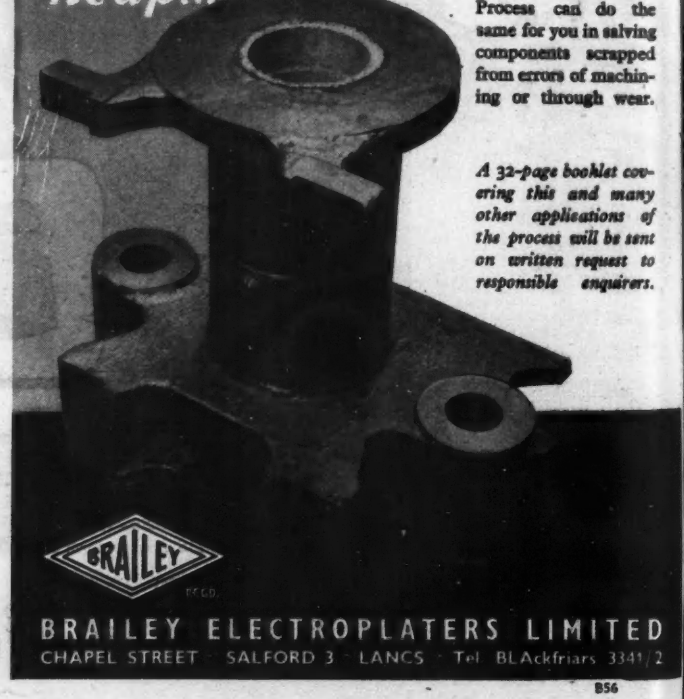

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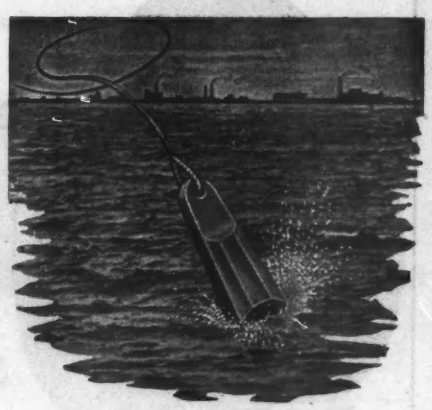

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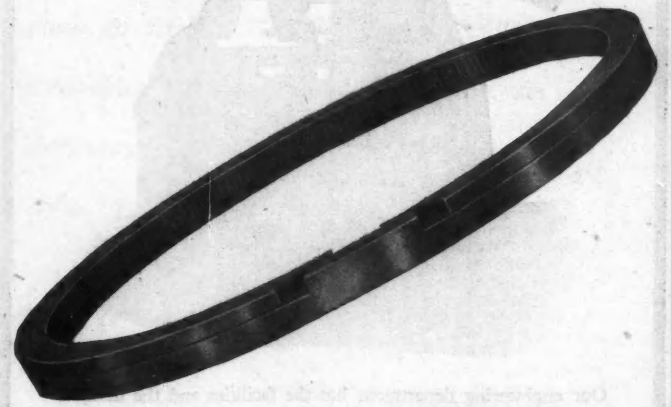

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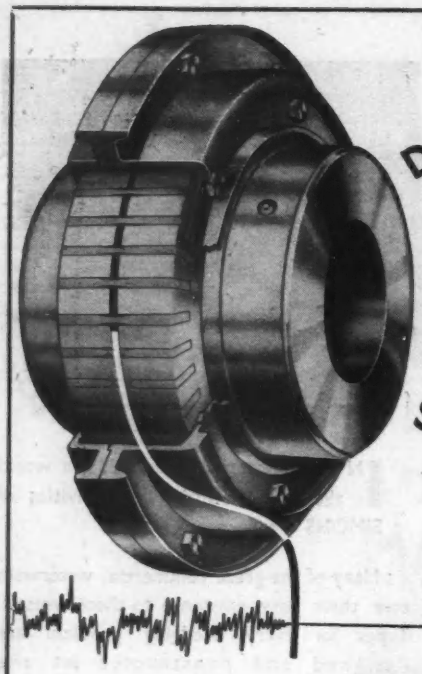

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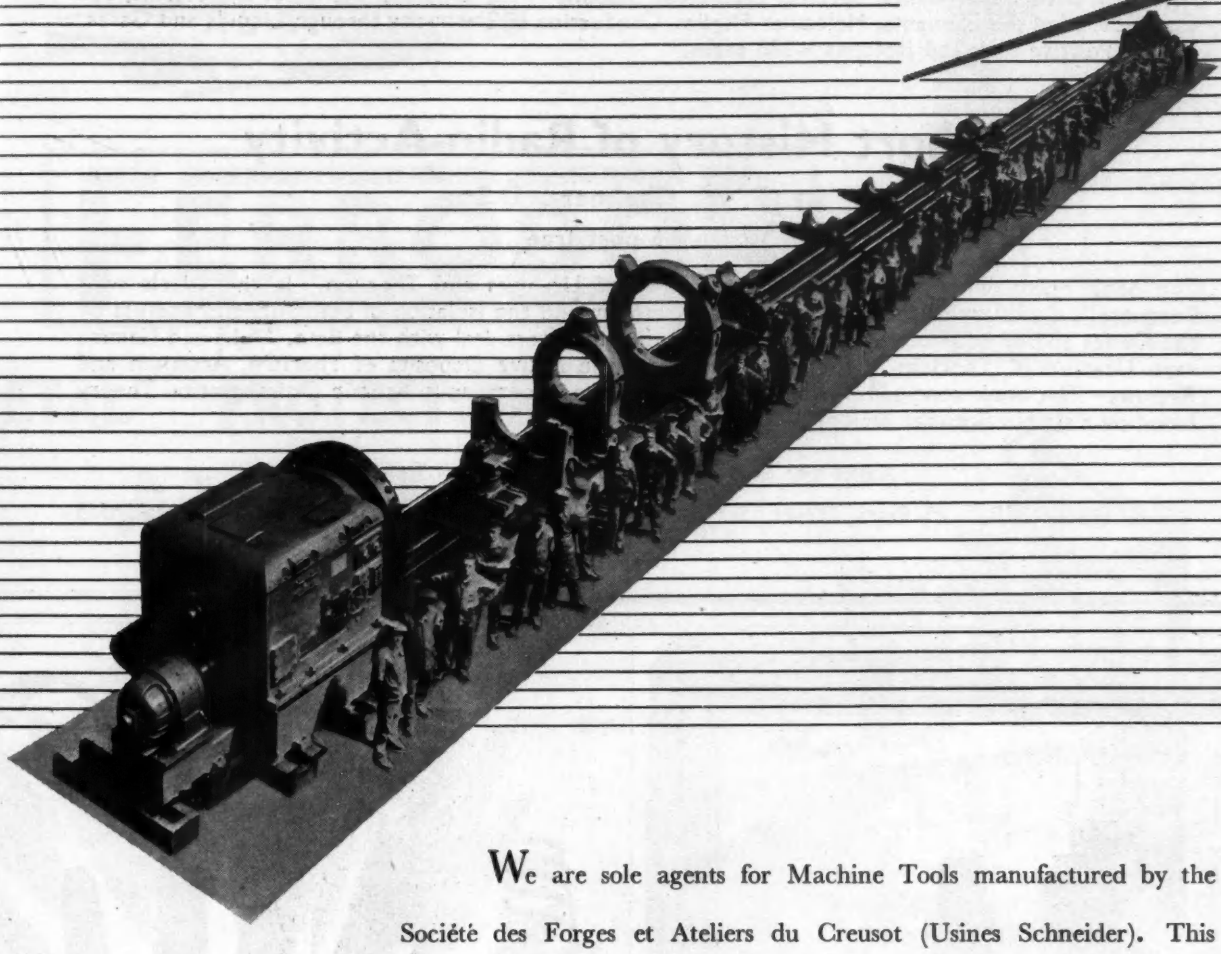

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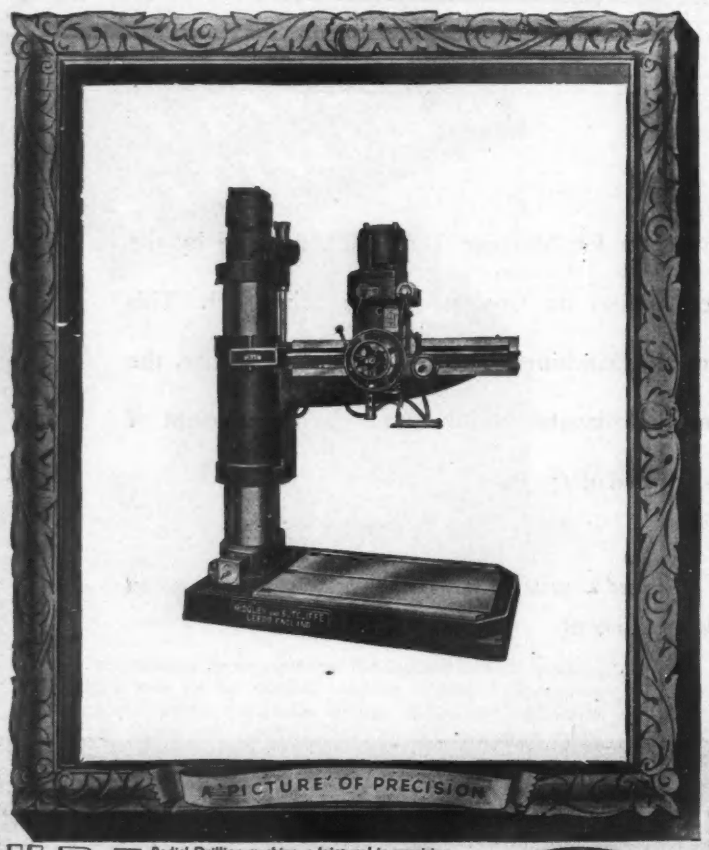

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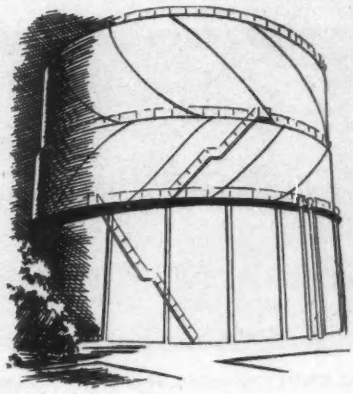

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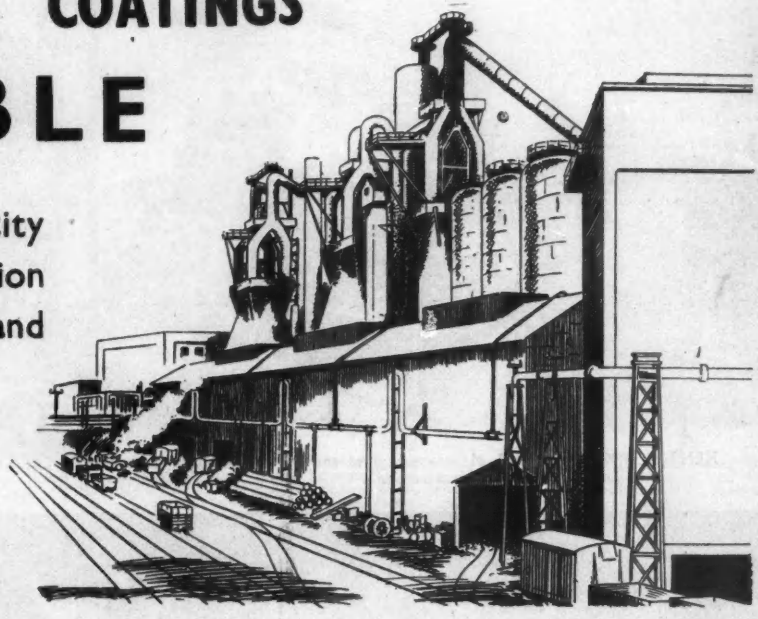

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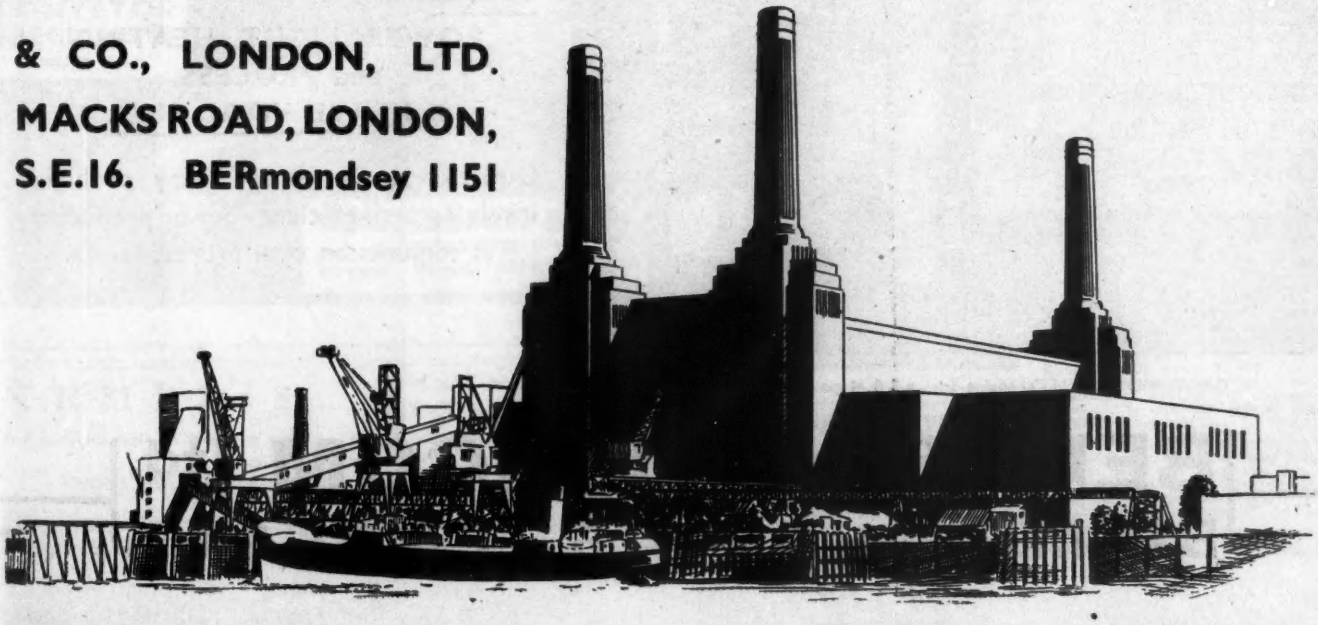

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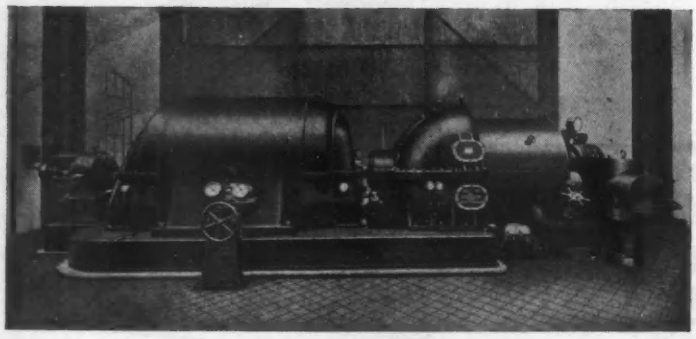

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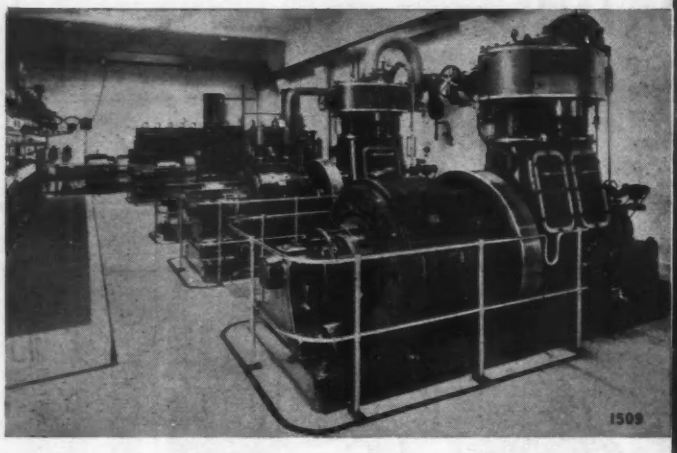

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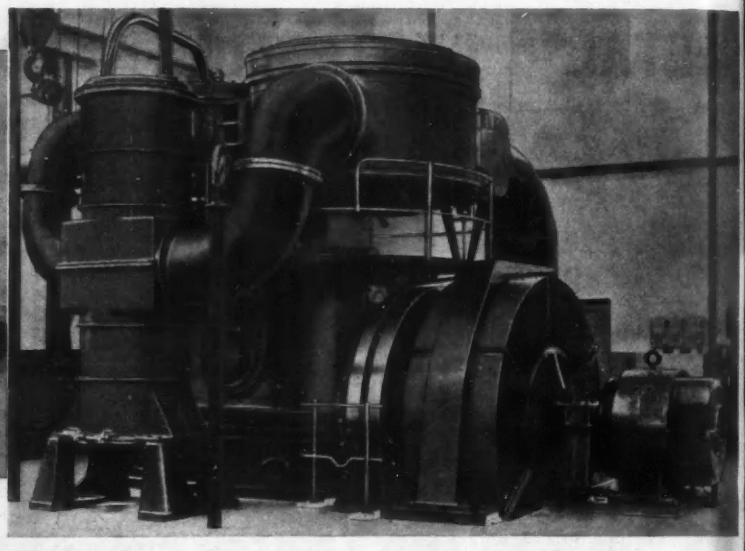

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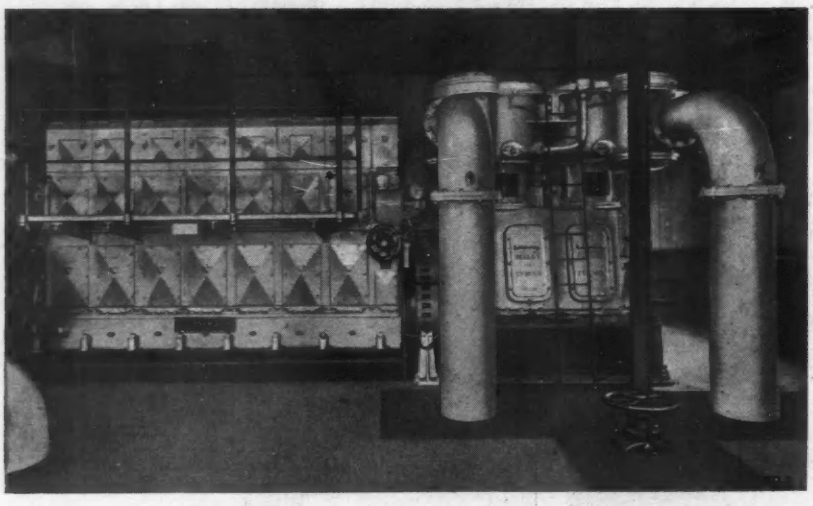

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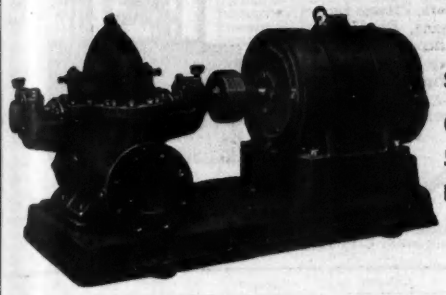

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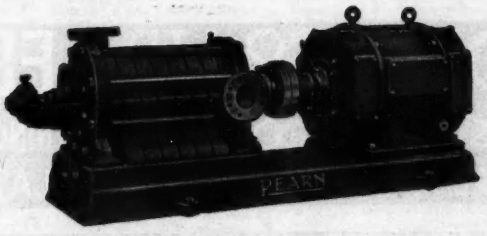

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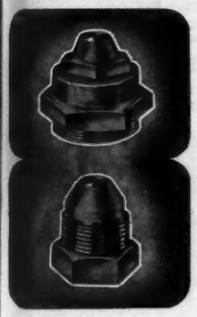

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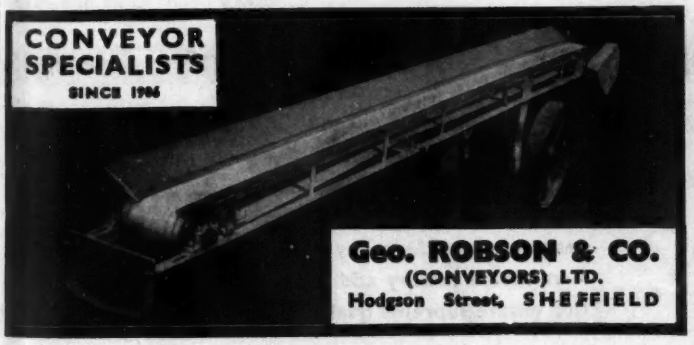

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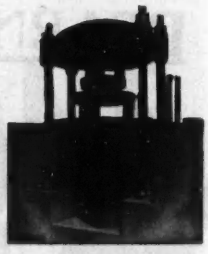

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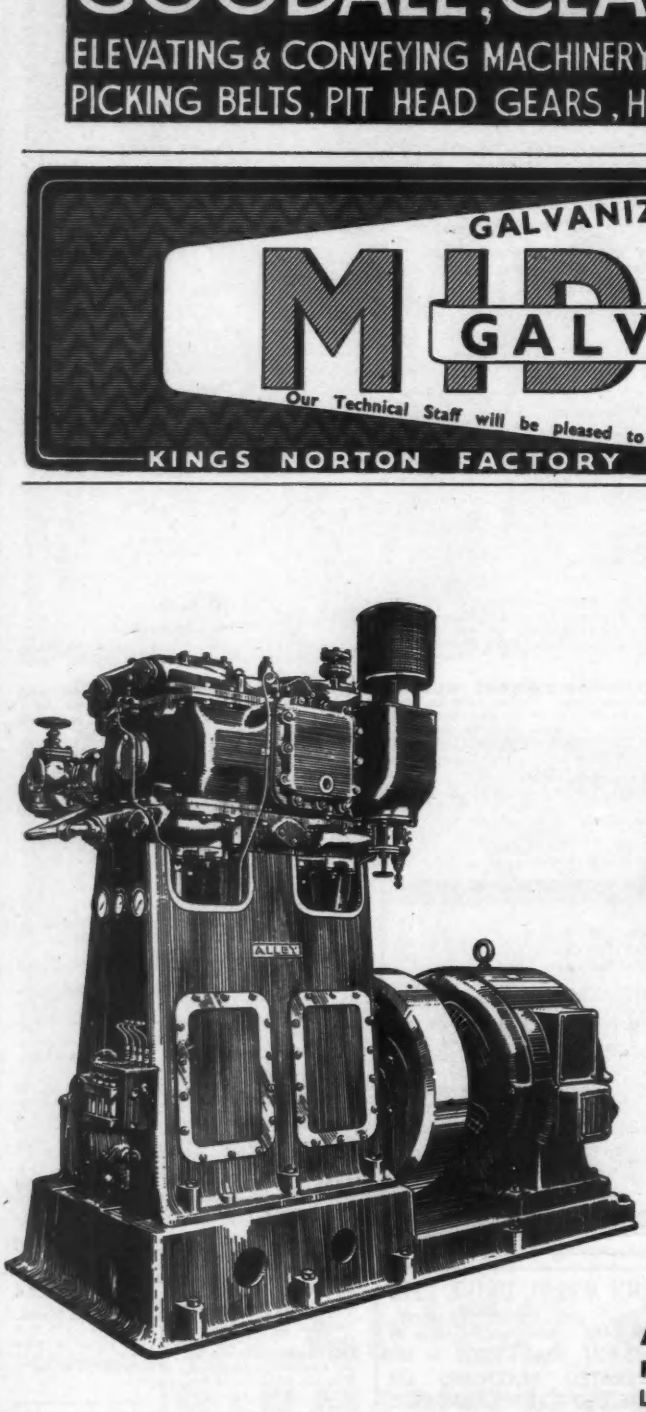

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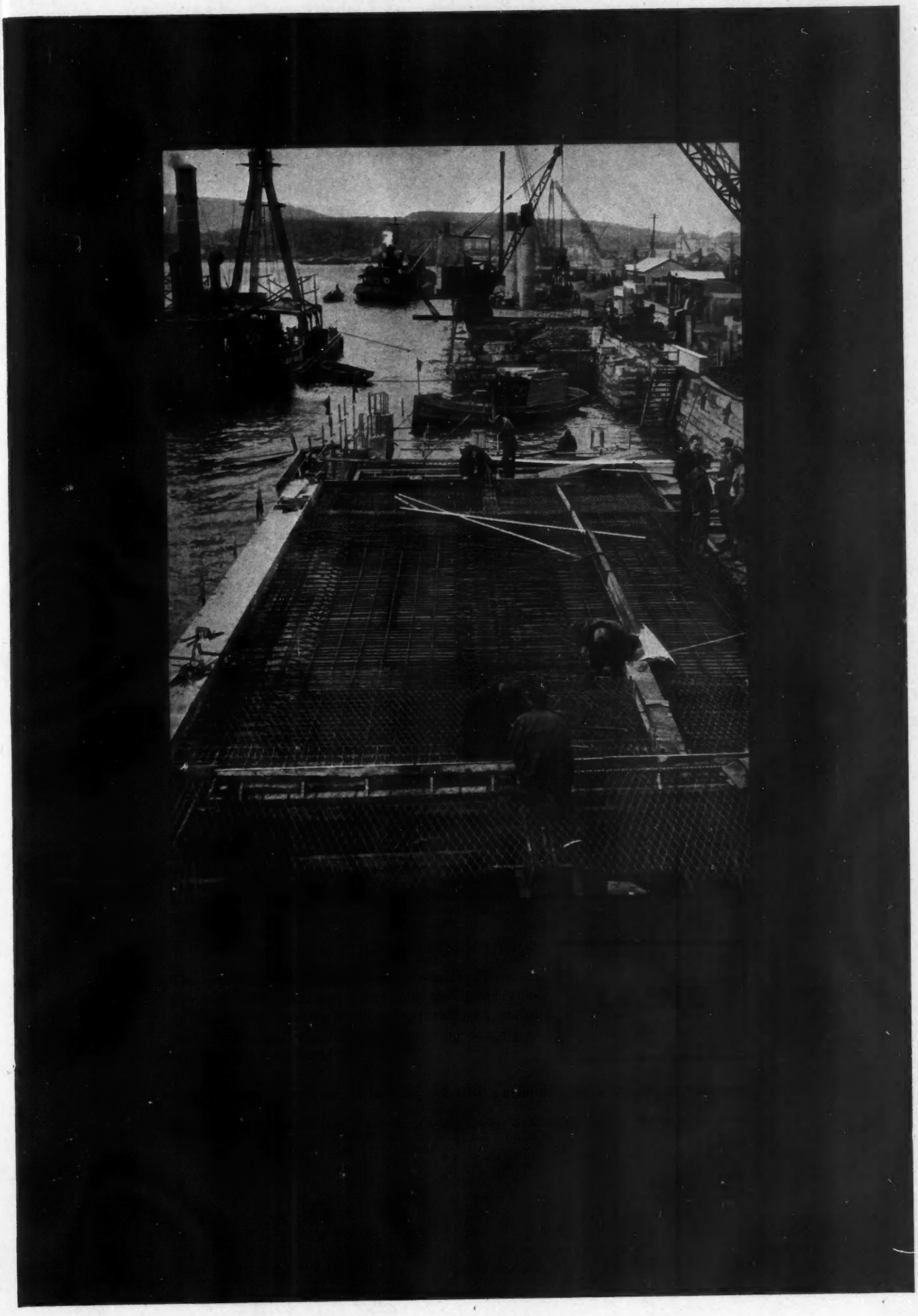

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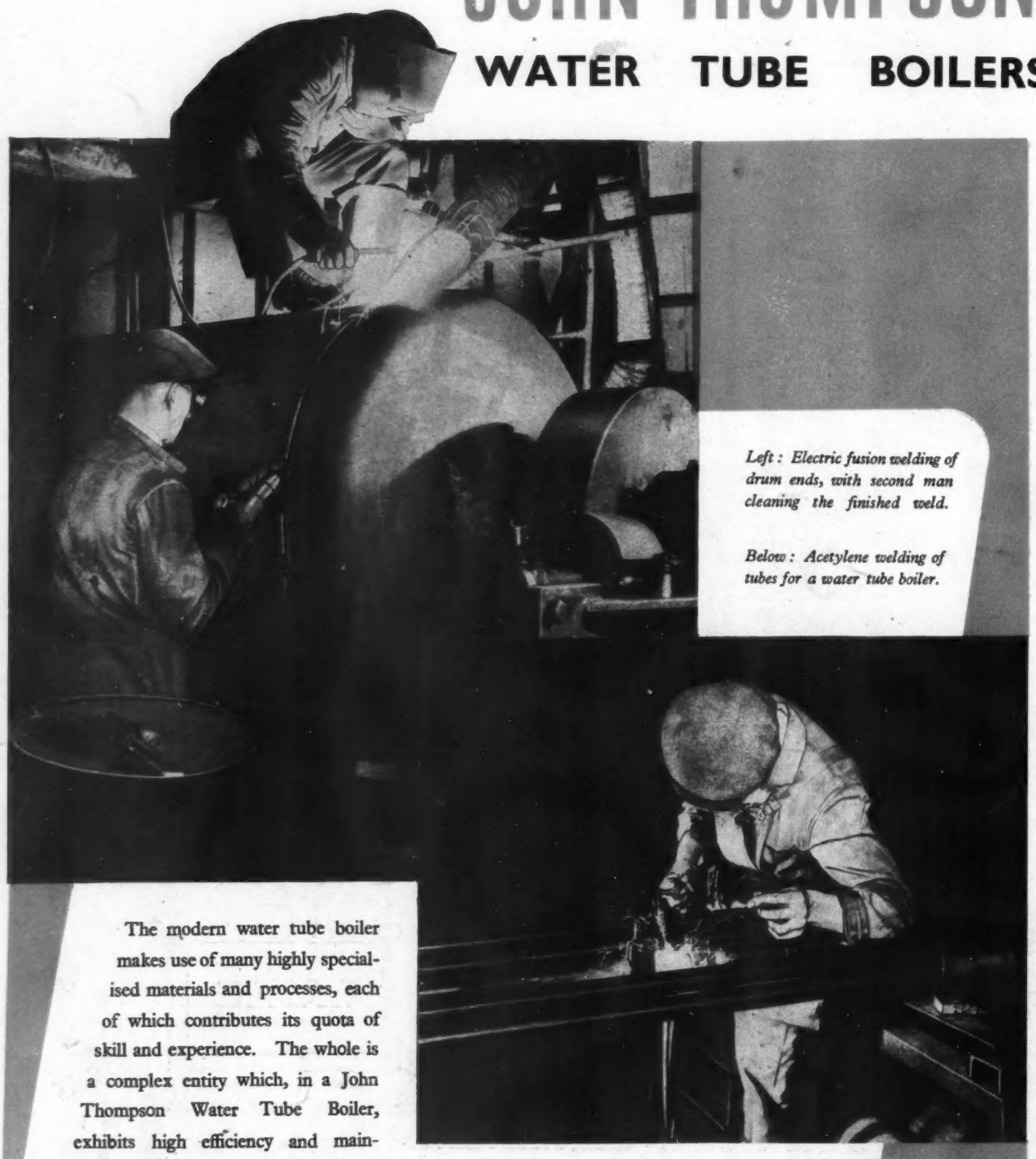

Left : Electric fusion welding of drum ends, with second man cleaning the finished weld.

Below : Acetylene welding of tubes for a water tube boiler.

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